

A N
E P I T O M E

OF THEORETICAL AND PRACTICAL
NAVIGATION, ^{534. 1273}
CONTAINING

A COMPLETE SYSTEM OF THAT ART,
GREATLY IMPROVED,

(And widely different from the present *laborious*, and, in some respects, *erroneous* Method of Teaching) from self-evident Demonstration, founded on many Years Experience in the several Voyages made by the Author;

MORE PARTICULARLY,

That to ST. HELENA, when appointed by the ROYAL SOCIETY, to observe the TRANSIT of VENUS over the SUN.

This Work is arranged under the following Heads, in a more easy and accurate manner than any hitherto published, viz.

CHRONOLOGY; the THEORY of TIDES; MAGNETISM, and the VARIATION of the NEEDLE;

GEOGRAPHY, with a large TABLE of the LATITUDE and LONGITUDE of Places in Europe, Asia, Africa and America; together with the TIMES of HIGH WATER at the principal Places;

GEOMETRY; THE CONSTRUCTION OF LOGARITHMS;

PLANE TRIGONOMETRY, with their APPLICATION to NAVIGATION;

The Method of making SEA CHARTS, finding the LATITUDE and LONGITUDE of a SHIP, and the VARIATION of the COMPASS:

With a NEW TABLE, shewing the TIMES of the RISING and SETTING of the SUN, MOON and STARS;

Also the Manner of finding the LEE-WAY, the SET and DRIFT of CURRENTS, and to CORRECT the DEAD RECKONING, &c.

All of which are exemplified in a JOURNAL from the DOWNS through the CHANNEL, from the LIZARD to MADEIRA, and from TENERIFF to ST. HELENA, with the Author's Remarks thereon;

As also the Form of keeping a Journal, and of collecting, with the greatest Facility, the Particulars thereof.

By ROBT. WADDINGTON,
TEACHER OF MATHEMATICS,

LATE MATHEMATICAL MASTER OF THE ROYAL ACADEMY AT PORTSMOUTH.

L O N D O N :

Printed for the Author; and Sold by J. NOURSE, Bookfeller to his Majesty, Strand; Messrs. WALLIS and STONEHOUSE, Ludgate-hill; Mr. SEWELL, Cornhill; and by Mr. FADON, Geographer to his Majesty, at the Corner of St. Martin's-lane, Strand. M,DCC,LXXVII.

COPIES OF THE
NAVY GAZETTE
CONTAINING

A COMPLETE HISTORY OF THE

NAVY

(including the history of the Royal Navy, and the history of the British Empire, from the first settlement in North America to the present time.)

BY

THOMAS BURNETT, Esq. of the Middle Temple, Barrister at Law.

THE SECOND EDITION, CORRECTED AND ENLARGED.

LONDON: Printed by J. BARNES, at the Crown and Anchor, in Strand.

MDCCCLXXXIII.

THE HISTORY OF THE

NAVY

FROM THE FIRST SETTLEMENT IN NORTH AMERICA TO THE PRESENT TIME.

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Also the Method of finding the Longitude by observing the Distance between the Sun and Moon, as also that between the Moon and Zodiacal Stars; with General Rules and an easy Method of Calculation.

To which is added a Copper Plate with Figures shewing the Nature of Refraction and Parallaxes, together with the Method of calculating them; likewise the Solar System (with the Calculation of the Distance of the Earth from the Sun; and of the Diameters and Distances of all the Planets), the Distance from the Earth and Planets to the Sun, computed from the Observations made on the Transits of Venus over the Sun in 1761 and 1769.

TO THE
RIGHT HONOURABLE THE EARL OF SANDWICH, MASTER;
WILLIAM JAMES, ESQUIRE, DEPUTY - MASTER;
AND THE
WARDENS AND ASSISTANTS, OF THE HONOURABLE CORPORATION
OF THE
T R I N I T Y H O U S E.

My LORD, SIR, and GENTLEMEN,

HOWEVER ill-qualified I may be, as a mere Mathematician, to write a florid DEDICATION; yet, when I consider to whom I address the following Pages, I feel myself more encouraged to the Task. I am a plain Man, and my Profession is *the Investigation of Truth*: And should nothing more appear in this TREATISE than the *Old Story* over and over again, treat it as it deserves, and the Author accordingly; but if, upon a fair and candid Perusal, several essential Improvements should be found, tending to the further Knowledge of Navigation, my Great End will be fully answered—as it will demonstrate that my Labours in Theoretical and Practical Experiments for thirty Years, have not been in vain; and consequently, I may humbly hope to reap the wished for Fruits of Approbation under your Auspices; especially, as in many Particulars they bear Analogy with several of the immediate Concerns of your respectable House.

I have the Honour to be,

with all Duty and Respect,

My LORD, SIR, and GENTLEMEN,

Your most faithful

and most obedient Servant,

R. WADDINGTON;

P R E F A C E.

THE numerous Publications already extant on the Subject of Navigation may appear to render this work unnecessary; yet, when it is considered that a clear, easy and practical method of keeping a Journal at Sea has not yet been fully explained, the following Treatise (some time since intended for publication) it is hoped, after an attentive perusal, will meet with the justice the Author flatters himself it merits. The young Navigator will here find every thing necessary for his instruction laid down in a methodical, though concise, manner, and so as to render every element applicable to Navigation attainable with the greatest facility, without the assistance of any other author on the subject, which hitherto has not been the case; not to mention the absurdities of many, some of which the Author thinks himself justified in quoting, that the Learner may not be misled, viz.

In the Coasting and Southern Pilots, the times of high water at various places on our coasts, are very erroneous.

	Moon bears by Pilots.	Times by them. h. m.	True Time of H.W. h. m.
Page 25, the Pilots say: Between Dover and Dungeness, and likewise thwart of the Nefs, H.W. when the moon bears	SSW.	1 30	10 30
In the channel off Winchelsea	SbE.	11 15	10 30
Beachy, by the shore, (current runs Easterly $3\frac{1}{2}$ h. after high water)	SSE.	10 30	10 15
At Spithead, (by p. 4, it runs from the needles 5 hours)	SEbS.	9 45	11 15
In the Fairway thwart off Spithead, moon SbE $\frac{1}{2}$ E.	S.	12 00	11 00

By the P I L O T S.

In the offing from the N. to the S. Foreland, it runs half tide;—that is, it runs half tide to the Southward, and then half tide to the Northward, before H. W.

From the South Foreland to Dungeness (or Dengyness) it runs half tide and half quarter;—that is, half tide Westerly, and half quarter tide towards the shore.

From the Nefs to Fairlee, it runs half tide;—that is, half tide to the West, and the other half tide towards the East.

From Fairlee to Beachy, it runs one quarter tide under another;—that is, the tides meet off this coast, and the set, or run, is towards the shore, after their meeting about the time of one quarter tide (or one hour and a half), the tide of flood then runs towards the Downs; but in the fair way of the channel, the flood tide runs towards the Downs at about half or three quarters of an hour after their meeting.

By the P I L O T S.

At East Borrowhead, at the Oars, Bembridge Flats, and off Dunnose, the flood tide runs 6 hours E. and ebbs $\left\{ \begin{smallmatrix} 2\frac{1}{2} \text{ E.} \\ 4\frac{1}{2} \text{ W.} \end{smallmatrix} \right\}$ nearly.

	Moon bears Points.	Time by them. h. m.	True Time of H.W. h. m.
P. 23. At the Buoy, off the Nore	SSE.	0 0	12 0
And North Foreland		0 0	10 30
25. Between Dover and the Nefs, and thwart the Nefs	SSW.	1 30	10 30
34. Between Calais and Dover SW. (at Calais S $\frac{2}{3}$ E. see p. 3.	SW.	3 00	10 30
At the mouth of the R. Somma SSE. and R. Seyn or Roan, SE. which may be nearly so.	SE.	9 0	10 30
36. Before the haven of Caen SSE. at Cherburg, and at C. la Hague, which is opposite to Peveral Point	SbE.	11 15	8 30
			8 00
40. In the Race of Blankart, at Alderney and Guernsey the flood sets NEbN.	NbE.	0 45	6 30
			7 00
44. At St. Maloes, Ushant, Minehead, Milford, Swansey	E. & W.	6 00	3 00
33. Lizard EbN. or $5\frac{3}{4}$ h. In Mount's Bay and Landsend	WSW.	4 30	4 15
Scilly ENE. or $4\frac{1}{2}$, and to the seaward of it in the channel	SWbW.	3 45	3 40

Note,

H. W. denotes high water.

Note, The time of the running or flowing of a tide, is 6 hours; of half a tide, 3 hours; of a quarter tide, $1\frac{1}{2}$ hour; and of a half-quarter tide, 3 quarters of an hour.

The flood sets from Scilly across the channel to the Lizard NE. and ebbs SW. which should be regarded.

61. Without Ushant (I suppose he means W. of it), the current runs WSW: 4h. 30m. (true time 3 h.).

So the Pilot reckons his times of high water at some places true time; at others, when the current has done running from the Atlantic, which by observation is three hours or more after it, when the ebb has fallen 10 or 12 feet at least; and this has been the cause of ships getting upon the sands, when the commanders expected they should have a sufficiency of water to carry them over; and at some other places, neither at one nor the other of these times.

In p. 25, the Pilot says, From Wight to Beachy the flood sets EbN. and ebbs WbS. He should have said, in the fair-way of the channel, at 5, 6 or 7 leagues, off these coasts; for between Dunnose and the Owers the flood sets N. over Bembridge flats; and near all coasts, at the time of flood tide, it sets inclining towards the coasts.

11. In Collin's Coasting Pilot, it is said to be H. W. at Deal at 9h. (true time 10h. 30 m.), also that it flows half tide and half quarter tide: What is to be learned from this, as he does not say which way it flows? How unintelligible it is, and can only tend to puzzle the generality of its Readers! N. B. The tide runs 2h. 10m. towards the S. and then 3h. $\frac{3}{4}$ to the Northward.

In p. 3, I have shewn that it runs in the Downs, from the N. to the S. Foreland, about 5 hours, and raises the water so as to make half tide, that is, the rise by flowing will be about half the height of the high water; it then turns, and flows to the Northward about 3 hours and $\frac{3}{4}$, and makes high water.

Remark. From the Lizard to the place of the meeting of the tides, off Fairlee, is about 270 miles; and if it be high water off the Lizard at half past 4, the swell, or run of the tide, must be 45 miles in an hour. Also the tides meet off Carlingford, in a parallel of lat. with the Southern part of the I. of Man in lat. $54^{\circ}.05'$ N. which is about 250 miles from the Land's-end; and as the time of high water off Carlingford, is at 9 hours, and off the Land's-end, about 4h. therefore it is 5 hours in running 245 miles, which 245 divided by 5, gives (49) miles that this tide flows or runs in an hour in this channel.

These tides stop one another off the I. of Man, and from thence the ebb is, both towards the N. and the S.

Tusker rocks are about 2 leagues from the shore, and E.bS. from Wexford; flows NNE. ebbs SSW.

P. 48. An E. and W. moon makes high water off Wexford; and before Waterford, an ENE. Moon. That is, before Waterford high water at 4h. 30m. and off Wexford, at 6 hours; that is, 30m. S. from Waterford, and 30m. E. from Wexford, the distance in the channel 60 miles.

In Wilson's Navigation, p. 197, it is said, H. W. at Dover Pier at 12h. in the Downs, at 1h. 30'. at Dover, at 10h. 30'. How inattentive will this author appear to have been, in so important a part of his work, when it is well known to be H. W. at all these places at the same time, and the reader may be convinced, by observations in p. 3. the fatal effects of which errors have been felt by many navigators, who have had the misfortune to be directed by them: For instance, ships have been lost on the Goodwin Sands, on the Oars, on Bembridge flats, and in many other parts in the channel; and if they have escaped those, yet they have frequently fallen into as bad a predicament, from a presumption that there was sufficient water nearer the coast, which in the event has proved the contrary, and been their total destruction. In Haseldon's Seaman's Daily Assistant, the calculations are equally absurd: He says, H. W. at Dover Pier, at 12h. thwart of Guernsey, 9h. 45'. Newport, Isle of Wight, $\frac{1}{2}$ tide, 12h. Portsmouth, $\frac{1}{4}$ tide, 11h. 15'. In the Sleeve, between Ushant and Scilly, at 12h. the W. end Isle of Wight, at 1h. 30'. Beachy by the shore, 8h. 15'. which are all wrong; and many more could with equal justice be mentioned.

I now turn to the subject matter of my own work only, viz. In p. 3 and 4 of the tides, of H. W. and of the time the current runs in the Downs, before and after H. W. each way; as also in St. Helen's Road and at Spithead, which should be strictly regarded.

In p. 29 to 40, are arranged the names of places, in the order they are situated along the coasts, with their times of high water, their latitudes and longitudes, and the variation of the needle.—Respecting the times of H. W. I was obliged to borrow from former authors, many of whom I am certain are wrong, as appeared by the observations made by me in the British Channel, and places adjacent thereto, which I think will readily be allowed for the following reason: And I heartily wish I had it in my power to make all necessary observations for the benefit of young navigators.

The tides meet of Dengeneß, as defined in p. 3. the channel tide runs towards the straits of Dover after the other tide is spent, into the German ocean, about 3 hours and a half; by reason of which excess of the channel tide, as it flows 6, 7, or 8 feet perpendicularly higher than the other, it runs about 3 hours and a half the same way after H. W. The like principle prevails in the running of the current towards the E. in the channel, about 3 hours after H. W. but with various bearings of sets, and velocity of drift, which must follow from a general principle of fluids.

The times of high water (on the full and change of the moon) being known at 3 or 4 places in the British channel, as also the like in St. George's channel; from which may be determined (nearly) the times of H. W. at all other places in, and adjacent to these channels.

The time of high water at Ushant, is 3 h. at Scilly, 3 h. 45 m. Land's-end, 4 h. 15 m. Lizard, 4 h. 30 m. St. Catherine's, I. of Wight, 9 h. and at Dover Pier at 10 h. 30 m. Hence are deduced the times of high water at Guernsey, Jersey and Sark, at 6 h. 30 m. Alderney and Caskets, 7½ h. Ram-head, 5 h. 40 m. Eddystone, 5½ h. Plymouth, 6 h. Start, 5 h. 50 m. Torbay and Dartmouth, 6½ h. Bill of Portland, and Weymouth, 7½ h. St. Alban's head, 7 h. 45 m. Peveral Point, 8 h. Pool, 9¼ h. Needles, 9 h. Shoreham, 10 h. Arundel, 9½ h. Beachy-head, 10 h. Dengeneß, 10¼ h. Note the distance between the S.E. line which passes through Scilly I. is about 34 miles from that which passes the Lizard point; hence the time of high water at the Lizard, must be 3 quarters of an hour later than at Scilly.

Note. The flood tide from the Atlantic Ocean sets into the British channel nearly N.E.

The Traverse Table (of diff. lat. and dep.) for each point and ¼ of the compass on a new plan, better adapted, and rendered more easy for practice; the figures are new and remarkable large, to prevent mistakes; particular care has likewise been taken in their calculation and revision to render them perfect.

Page 76 shews the principles of the Plane Chart.—84, 85, and following pages, the improved method of making Mercator's and Reduced Charts.

Page 91 and following, accurate Tables of the Sun's Declination, with a Table for readily obtaining the rising and setting of the sun, moon and stars.

Page 101 and following, an improved method of working days works, and of keeping a Journal at sea; also of correcting dead reckonings, and comparing these rules with others less perfect.

Great Circle Sailing, never before sufficiently explained so as to make it practical, which is done in p. 128, in an easy and general method.

In the examples of the different parts of Navigation, Logarithms are only used in some particular cases, and there, in order to shew the comparison of that method, and of this by the Traverse Tables, whereby it appears, that the working by the Traverse Tables are quite sufficient for the purposes of navigation in general. I have, therefore, omitted publishing a table of logarithms, and have fully elucidated the use of those tables in working the day works of a long Journal. But as the young navigator may have occasion for a book of logarithms, to work the various cases of Trigonometry, as also for the working of Amplitudes, Azimuths, &c. I therefore propose to publish a small treatise on the subject of Trigonometry, with all necessary Tables of Logarithms, and their use in the various branches of the Mathematics. Those who work longitude observations, taken by the moon and sun, or moon and star, should have either Sherwin's 3d edition, or the French edition of Gardiner's Tables, where the sines and tangents of arcs or angles, are taken out at sight for each 10 seconds of the minutes of a degree; [price 2l. 7s. sold by Mr. Nourse, bookseller to his majesty, Strand.]

N. B. The later edit. of Sherwin's Log. are greatly defective, and the last edit. the worst, the figures being small, &c. and not fit for the purpose.

Remark,

Remarks on the work of a modern Author on Navigation, who has taken many parts from mine, and from other Treatises on the subject.—See the Appendix.

In Jeffrey's Survey of Yorkshire, He makes Flambro'-head to lie under the meridian of London, and the Spurn in latitude $53^{\circ}.35'$ N. $6'$ E. longitude.

By my Observations, The Light-house on Flambro'-head, $54^{\circ}.8'.20''$ N. lon. $3'$ E.

Ditto on the Spurn, - $53^{\circ}.34'.20''$ N. lon. $11'$ E.

The Light-house on the Spurn, bears from St. Trinity Church at Hull, S. $51^{\circ}.50'$ E. or SE. $1^{\circ}.13'$ E. distance 16 miles. Dep. 13,2—X lon. $23'$: $\therefore$ Hull is $12'$ W. lon. and the Spurn L.H. $11'$ E.

ERRORS and OMISSIONS.

In Ex. 1, p. 3, the time of H. W. was taken $45'$ at the Nore, which happens when the wind is high and nearly E. to be 3 quarters of an hour later than common.

PAGE 30 Flamborough-head, for 0.56 E. read $0^{\circ}.06'$ E.

41 of Geography, l. 38, for 1557, read 1576.

42 ——— l. 17, for 1514, r. 1614.

44 in the Errata, before l. 9, r. in p. 120.

P. 1 of Geometry, def. 8. see pl. 1. fig. A. B. C. def. 9, fig. G. p. 3, see fig. pl. 1.

4, prob. 5, l. 3, r. to touch the line AF. l. 5, r. the given line AF.

do. 8, l. 6, for BF. r. BE.

do. 14, l. 3, r. line A. dele C.

do. 17, l. 8, dele D. l. 10, for bd r. bD . l. 12, with $AD = 110^{\circ}$.

do. 20, l. 1, dele right. p. 7. def. 6, see pl. 2. figs. A. a. at the foot.

P. 7, Geometrical Theorems.

Theo. 1, 2, 3, 4, 5, 6, see pl. 2, figs. 1, 2, &c. Theo. 7, 8, figs. 6, 5.

Theo. 2, l. 8, $\angle b = 100^{\circ}.13' = \angle C$. p. 9, the two last lines, r. but 4 has a greater ratio to 2, than to 3.

P. 11, in Dem. of 18th Theo. l. 4, r. which contain, or subtend.

25, in Dem. of 4th Theo. for Theo. 15, r. 20. also by 47, 3, Euclid's corollary.

32, for t. of $45^{\circ}.30'$, r. 10,00758 and the t. of $\frac{1}{2}$ diff. $\angle \angle = 0^{\circ}.50'$, the $\angle C = 46^{\circ}.20'$ } &c.
also $AC = 146,9$. and $\angle A = 44^{\circ}.30'$

34, def. 9 and 10, see pl. 4, fig. 33 and 28. p. 47, l. 35, for some, r. sum.

39, the columns, for D. Lat. and Dep. correct to Dep. and D. Lat.

Over 63° Trav. Table, last col. r. Lat. for Dep. and under 27° , r. Dep. for Lat. the same over 55° , last col. and Dep. for Lat. at the top.

Over 60° , last col. for Dep. r. Lat. and for Lat. at top, r. Dep.

54, l. 11, $BE + GC = DF$; and for EC, r. EG. p. 55, l. 4, dele and. See fig. 11.

55, Prob. 4, l. 6, after construction, for ANd , r. NAd .

56, in the 1st Ex. see pl. 3, fig. 23.—p. 69, l. 12, for CBf , r. XBf .—l. 18, r. Theo. 1, part 2—p. 60, l. 2, for $P90$ and $S90$, r. P. E. S. W.

The meridians of fig. 28. are drawn at each 10° from the meridian passing through O, and not at 15° , as mentioned in the construction.

85, l. 23, r. lines parallel to AB, as DE, CF, &c. See p. 5.

94, l. 2, for 1779, r. 1799. See p. 44 of Geography.

117, At 2 A.M. the course was SSW, and against it lee-way $\frac{1}{4}$, and not $1\frac{3}{4}$.

Also against SWbW. wind, L.W. 1 point—and against 4 and 5 h. the courses SbW, and SWbS. the mean is SSW. L.W. 1 point.

Notwithstanding the greatest attention has been paid to this work, some errors (of the press) may have escaped notice, which, from the nature of it, is next to an impossibility to avoid; and which, it is hoped, the candid reader will excuse.

O F

C H R O N O L O G Y.

CHRONOLOGY is the Science of computing and adjusting the periods of Time.

A Cycle, or Period, is a Revolution of Time.

The Cycle of the Sun, or the Dominical Letter, is a period of 28 years.

The Cycle of the Moon, or of the Golden Number, is a Period of 19 Years, which period being compleated, the New and Full Moons return to the same month, and on the same days of the month; so that whatever days the New and Full Moons are in this year, they will, 19 years hence, happen on the same days of the months, and within an hour and a half of the same time of the days through the year.

The parts of Time are Years, Month, Weeks, Days, Hours, Minutes and Seconds.

The Julian common year consists of 365 days, and the Julian Leap-year of 366, which is every fourth year*. A Lunar year consists of 354 days, which is 11 days less than the Solar. The Solar year contains 365 days, 5 h. 48 m. 55 f. and in which time there happens 12 periods of the Moon, or New Moons, and 11 days over.

The seasons in the Northern Hemisphere are, Spring, when the Sun enters Aries, which is on the 20th or 21st of March. Summer, when the Sun enters Cancer, the 20th or 21st of June. Autumn, when the Sun enters the Equinox Libra, the 21st or 22d of September. And the Winter season or quarter begins, when the Sun enters the Solstitial Colure, which is the beginning of Capricorn, the 20th or 21st of December.

Of the GOLDEN NUMBER and E P A C T.

DEF. I. The Prime or Golden Number is the year or period of the Moon, which period contains 19 years; and when the new Moon happens on the last day of December, the Prime of the following year will be 1.

II. The Epact is the difference in whole days betwixt the common Julian and the Lunar year; and is reckoned from the last new Moon of any year to the beginning of the succeeding one.

III. The Epact of a given year, is the age of the Moon the last day (at noon) of the preceding year; whence in January, the Epact added to the day of the month gives the Moon's age.

To find the PRIME or GOLDEN NUMBER.

Rule I. Add 1 to the year of Christ, divide the sum by 19, the remainder will be the Prime; but if 0 remains, 19 is the Golden Number.

To find the E P A C T.

Rule II. Take 1 from the Prime of the given year, multiply the remainder by 11, the product, if less than 29, is the Epact; but if the product exceeds 29, divide it by 30 and the remainder will be the Epact.

Note. When the Prime is 1, then the Epact is 0.

The numbers for the months, which are to be added to the Epact of a given year, to get the Age of the Moon.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
In common years	0	2	0	2	2	4	4	6	7	8	9	10
In leap-years	0	2	1	3	3	5	5	7	8	9	10	11

* Except such Leap-years of the Hundreds, which are not divisible by 4: for 17, 18, 19, are not divisible by 4, without a remainder, therefore they are common years. See the Remark, page 4.

The reason of a day being added to the number of the months in leap-years after Feb. is because of the intercalary day in those years.

To find the MOON'S AGE.

Rule III. To the Epact for the given year, add the number for the month and the day of the month, the sum, if less than 30, is the Moon's age; but if it exceeds 30, take 30 from it, and the remainder will be her age.

To find the time the Moon passes the Meridian, and of High Water.

Rule IV. Multiply the Moon's age by 4, and divide the product by 5, the quotient will be the hours, and the remainder multiplied by 12, will be the minutes of its passage over the Meridian, nearly; but the true time is to be found by the Nautical Ephemeris, or by the Astronomical Tables.

To find the Time of HIGH WATER.

To the time the Moon passes the Meridian, add the time of High Water at the full or change days of the Moon, the sum, if less than 12 hours, will be the time required: But if it exceeds 12 or 24 hours, subtract 12 or 24 from it, and the remainder will be the time required.

Note, By this rule, the time of H. W. in general, is found; therefore the time is to be taken either in the morning or in the afternoon of the same day; and not at the time A. M. or P. M. as that requires the true, and not the mean Age of the Moon.

A TABLE of the Bearings of the Moon at the Time of High Water; with the Time of those Bearings, at the following Places.

When the Moon bears as follows it will be		High Water at the following Places.	
N. and	S.	h.	{ Isle of Alderney, Gibraltar, Southampton, Nore, Sheerness, and along the Swin, to the Mouth of the River Thames.
N. by E.	S. by W.	12	
N.N.E.	S.S.W.	0 $\frac{3}{4}$	{ or 45 m. past 12, Rochester, Flushing, Malden.
N. E. by N.	S. W. by S.	1 $\frac{1}{2}$	
N.E.	S.W.	2 $\frac{1}{4}$	{ or 30 m. past 1, Bellisle, Tinmouth, Gravesend, Holyhead.
N.E. by E.	S.W. by W.	3	
E.N.E.	W.S.W.	3 $\frac{3}{4}$	{ or 15 m. past 2, Berwick, Lisbon, St. Andrew's, Conquet.
E. by N.	W. by S.	4 $\frac{1}{2}$	
E.	W.	5 $\frac{1}{4}$	{ Whitby, London, Amsterdam, Bourdeaux, Bay of Biscay.
E. by S.	W. by N.	6	
E.S.E.	W.N.W.	6 $\frac{3}{4}$	{ Brest, Huntcliff, I. of Bas, at the Maes, Scarborough.
S.E. by E.	N.W. by W.	7 $\frac{1}{2}$	
S.E.	N.W.	8 $\frac{1}{4}$	{ In Bresound, Ushant, Scilly, Cork, C. Clear, Edinburgh.
S.E. by S.	N.W. by N.	9	
S.S.E.	N.N.W.	9 $\frac{3}{4}$	{ Humber Mouth, at the Spurn, Torbay, Start Point.
S. by E.	N. by W.	10 $\frac{1}{2}$	
S.	N.	11 $\frac{1}{4}$	{ Hull, Wells, Weymouth, Plymouth, Ramhead, Boston.
		12	
			{ Bristol, Portland Road, Lynn, Foulness, Foy.
			{ Lizard, Land's End, Falmouth, Penryn, C. Barfleur.
			{ Eddystone, Yarmouth, Needles, Fly, Dublin, I. Fly.
			{ Isle of Man, Isle of Wight, E. End, Caskets, Caen, Lowestoff.
			{ N. Foreland, Dungeness, Dunnose, Shoreham, Orfordness.
			{ The Downs, Deal, Dover, S. Foreland, St. Helen's, Beachy.
			{ Margate, Harwich, Rose, Pool, Portsmouth, Spithead, Calais.
			{ Dunkirk, Embden, R. Elbe, Coast of Flanders, Ostend.

In the year 1770, I observed the setting of the Current in the Downs at each hour, from the time of High Water which was before the New Moon, till the following Tide of High Water, which happened to be after the change of the Moon: The next day I observed it at Dover; from which it appears that High Water at Deal, in the Downs, and at Dover, is nearly at the same time; which was at 10 h. 30 m. on the day of the change. The current ran three hours and a half after High Water to the Northward, and then the Flood Tide set in from the North to the Southward, it continued flowing 5 h. and 10 m. when the Flood Tide from the Southward began and continued running 3 h. 45 m. and then made High Water.

From the foregoing, may be drawn the particulars following:

H. W. on the Full and Change days, at 10 h. 30 m. in the Downs, at Deal and Dover.
 The current runs to Northward, after H.W. 3 $\frac{1}{2}$ h. 30 m. done running to N. at 2 h. 00 m.
 The current runs to Southward at $\frac{1}{2}$ ebb for 3 h. 00 m. and makes Low Water at 5 h. 10 m.
 Flows from the N. - - - - - 2 h. 10 m. and makes $\frac{1}{2}$ Tide nearly at 7 h. 10 m.
 Channel Tide flows to Northward - - - 3 h. 45 m. and makes H.W. at 10 h. 55 m.
 The second High Water after the Full and Change of the Moon.

Note,

Note, The Current in the Downs generally runs 7 h. and $\frac{1}{4}$ to the North, and 5 h. and $\frac{1}{2}$ to the Southward.

At Dover, the Tide from the Channel runs to the Northwards 7 h. 15 m. and from the North 5 h. 10 m. at the Full and Change of the Moon.

At 4 or 5 leagues W. of the Rip-raps, the Tides meet off Fairleigh at $\frac{1}{4}$ before 6; and the Channel Tides flow from thence towards the Downs at 6 $\frac{1}{2}$, and reaches the Downs at 7.

Note, The Tides set in the Downs N.N.E. and S.S.W. nearly.

Spring Tides flow 24 feet, Neep Tides 12.

At Dover they hoist a flag at the Jetty, when the Tide has flowed 10 feet high in the mouth of the harbour.

The Tide generally ebbs or falls 10 or 12 feet in the harbour, before the Current in the offing has done running towards the North East.

A TABLE of the shifting of the Tides, according to the Age of the Moon; by which appears the Error of reckoning High Water to be $\frac{1}{4}$ of an Hour later each succeeding Day.

Moon's Age.	H. W. later than on full & ch. day.	Mean of the Time.	Moon's Age.	H. W. later than on full & ch. day.	Mean of the Time.	H. W. at Deal, Dover, in the Downs and St. Helen's.	
Days.	h. m.	h. m. f.	Days.	h. m.	h. m. f.	h. m.	diff.
1	0 44	0 48 48	16	0 56	1 00 48	11 14	44'
2	1 22	1 37 36	17	1 34	1 49 36	11 52	38
3	1 56	2 26 24	18	2 08	2 38 24	12 26	34
4	2 28	3 15 12	19	2 40	3 27 12	12 56	32
5	3 02	4 4 00	20	3 14	4 16 00	1 32	34
6	3 40	4 52 48	21	3 52	5 4 48	2 10	38
7	4 24	5 41 36	22	4 36	5 53 36	2 54	44
8	5 12	6 30 24	23	5 22	6 42 24	3 42	48
9	6 04	7 19 12	24	6 16	7 31 12	4 34	52
10	7 04	8 8 00	25	7 18	8 20 00	5 34	60
11	8 08	8 56 48	26	8 22	9 8 48	6 38	64
12	9 12	9 45 36	27	9 26	9 57 36	7 42	64
13	10 15	10 34 24	28	10 30	10 46 24	8 45	63
14	11 16	11 23 12	29	11 32	11 36 12	9 46	61
15	12 12	12 12 00	29 12 $\frac{1}{2}$	12 00	12 00 00	10 42	56

From 1 to 15 Days old, and from 15 to 30.

The mean time of the period of the Moon from change to change, is 29 days, 12 h. 44 m. in which time the tides make a period through the 24 hours, and making High Water each day later than the foregoing day, as inserted in the table of the shifting of the Tides in the columns under H.W. later, and against the age of the Moon.

To find the time of High Water at any place, where the time of High Water is known on the Full and Change Days of the Moon.

To the time of H.W. on the New or Full Moon at the given place, add the time of the shifting of the Tides, in the column against the Moon's age, the sum will be the time required.

Ex. I. At what time will it be High Water at the Nore, the 10th of January, 1784?

By the foregoing table, a N.bE. and a S.bW. Moon makes High Water at 0 h. 45 m. Moon's age 17 days, by table gives

The Time of High Water

Ex. II. At what time may a ship in the Downs fail to the Southward, with the first of the Current, the 21st of January, 1784?

A S.S.E. and N.N.W. Moon makes H.W. on the Full and Change days at 10 h. 30 m.

For 28 days Moon's age, add

High Water at

The Current runs towards the North after H.W. in the Downs

The ship may fail for the Channel at

Ex.

Note. H. W. denotes High Water.

Ex. III. At what time may a ship sail from Spithead for the Channel by Dunnose? Also at what time must she fail to pass through the Needles the 26th July, 1784?

To solve this question, observe, that the Tide which comes through the Needles to Spithead, runs there till half past nine on the Full and Change days; and at St. Helen's Road, it runs till nine; when the Tide from the Channel, which comes round Dunnose and enters the mouth of the Channel between Bembridge Point and Selsey, prevails and makes H.W. in St. Helen's Road at 10 h. 30 m. and at Spithead at 11 h. 15 m. these Currents set, in direction of this Channel, which is E.N.E. and W.N.W. from its mouth to the Offing of Calshot Castle, or between it and Cowes, in the Isle of Wight; the Channel then nearly lies W.S.W. and E.N.E. to the Needles; but to Southampton it lies N.W.

Full Tide from the Needles at Spithead, at New and Full Moon	-	9	30
July 26th, 1784, Moon 8 days old, for which add	-	5	12
The ship may sail towards the Needles, that Tide done running, at	-	2	42
The current runs to the W.N.W. before H.W. about	-	1	43
And makes High Water at Spithead, at	-	4	25
The Current runs towards the Needles after H.W.	-	5	35
The ship may sail for the Channel, at	-	10	00
The Current runs from the Needles, at Spithead	-	5	05
And makes Half Tide at Spithead, Cowes, &c. and may fail to the Needles at	-	3	05
The Current from St. Helen's runs, at Spithead	-	1	45
And makes H.W. at Spithead, and on the opposite coasts, at	-	4	50
The Tide flows about 6 h. and ebbs 6 h. 25 m.			

C H R O N O L O G Y.

A TABLE of the PRIMES and EPOCHS from the Year 1767 till 1918.

G. N.	Epoch.	Years.	Years.	Years.	Years.	Years.	Years.	Years.	Years.
1	0	1767	1786	1805	1824	1843	1862	1881	1900
2	11	B 8	7	6	25	B 44	63	82	1
3	22	9	B 8	7	26	45	B 64	83	2
4	3	1770	9	B 1808	27	46	65	B 84	3
5	14	1	1790	9	B 28	47	66	85	B 4
6	25	B 2	1	1810	29	B 48	67	86	5
7	6	3	B 2	11	30	49	B 68	87	6
8	17	4	3	B 12	31	50	69	B 88	7
9	28	5	4	13	B 32	51	70	89	B 8
10	9	B 6	5	14	33	B 52	71	1890	9
11	20	7	B 6	15	34	53	B 72	91	1910
12	1	8	7	B 16	35	54	73	B 92	11
13	12	9	8	17	B 36	55	74	93	B 12
14	23	B 1780	9	18	37	B 56	75	94	13
15	4	1	C 1800	19	38	57	B 76	95	14
16	15	2	1	B 20	39	58	77	B 96	15
17	26	3	2	21	B 40	59	78	97	B 16
18	7	B 4	3	22	41	B 1860	79	98	17
19	18	5	B 4	23	42	61	B 1880	99	1918

Remark, That three Intercalary Days are to be omitted in every 400 years; i. e. the number of entire hundreds, not divisible by 4, such as 1700, 1800, 1900, 2100, &c. should be only common years.

Note, The Tide from the North Sea, which meets the Channel Tide off the English coast, between Dengeness and Fairleigh, sets almost an hour after their meeting, towards the English and French coasts, and it then flows towards the Downs. Observe C, for common, and B, bissextile years

OF THE T I D E S.

Of the THEORY of the TIDES, as demonstrated by Sir Isaac Newton*.

In V. II. B. 3. Prop. 24, 25.

BY the Principle of Gravity, whereby in the Earth all Bodies have a Tendency towards its Centre, as is most evident; and that there is such a Gravitation towards the Centre of the Sun, Moon, and all the Planets†.

2. From this Principle, as a necessary Consequence, follows the Spherical Figure of the Earth (Land and Sea), and of all the other Celestial Bodies: And though the Tenacity and Firmness of the solid Parts support the inequalities of the Land above the Level, yet the Fluids‡, pressing equally, and easily yielding to each other, soon restore the Equilibrium, if disturbed, and maintain the exact Figure, as formed by Gravitation.

* 3. The Force of Gravitation, and of the Descent of Bodies towards the Earth's Centre, is less and less as the Distance from the Surface of the Earth increases; and Sir I. Newton has demonstrated, that this Force decreases, as the Square of the Distance increases§; that is, the Weight of Bodies, and the Force of their Fall, is less in Proportion of the Squares of the Distances from the Earth's Centre.

A TABLE shewing the Force of Gravity, or the Weight of Bodies at different Distances from the Surface of the Earth.

Let the Radius of the Earth be called 1; and suppose a Body on its Surface to weigh 1 Ton or 20 C. Weight, if this Body be supposed to be removed to 1, 2, 3, &c. Semidiameters from the Earth, then by the Table;

Dist. from Centre Semidiameters.	Weight, Hund.
1	20
2	5
3	$2\frac{2}{3}$
4	$1\frac{1}{4}$
5	$0\frac{4}{5}$
6	$0\frac{5}{6}$

4. By this Law it appears that Gravitation is universal.

But the internal Gravity of Bodies within the Earth's Surface decreases as the Distance from the Centre; therefore a Body in the Centre can have no Weight, it being in the Centre, and therefore not distant from it.

And in these proportions does the Fall of Bodies increase and decrease, whether without or within the Earth's Surface.

For, whereas near its Surface all heavy Bodies fall 16,1 feet in one second of time; and at 1 semidiameter above it, the Fall would be only $4\frac{1}{4}$ feet, in that time. And at 4 semidiameters from the Centre, it would only fall $\frac{1}{16}$ of that at the Surface, or 1 foot and $\frac{1}{16}$, and so on less and less; yet at all Distances it is something, though the Effect becomes insensible.

5. The Ratio of the Fall of Bodies towards the Earth is as the Square of the time.

6. And the Decrease of Gravity is as the Square of the Distance from the gravitating Body.

7. At the Distance of the Moon, which suppose 60 Semidiameters of the Earth, the Force of Gravity is only $\frac{1}{3600}$ part of that at the Earth's Surface; and the Fall of a Body towards the Earth from thence, is only $\frac{1}{3600}$ part of that at the Earth's Surface: Hence the Inclination of a Body at the Distance of the Moon, to fall towards the Earth, is 16 feet in a minute; that is the same Distance in a minute, as at the Earth in 1" of Time.

8. The same Force is evidently found (by observations of the Planets motions round the Sun) in the Sun, Moon, and all the Planets; but in the Sun it is prodigious great, and acts through the Planetary System, and so that the Force of Gravity in the Celestial Spheres, acts proportional to their Quantities of Matter; and the Sun being at least 1,000,000 times as big as the Earth, its Gravitation or attracting Force will be at least 250,000 times as much as that of the Earth, acting on Bodies at the same Distance.

B

The

* Principia, V. II. Prop. 9. p. 229. The Density of the Earth 400; the Sun 100; Jupiter 94 $\frac{1}{2}$; Saturn 67.

† Gravitation of every Particle of Matter within the Surface of the Earth, is in respect of the Centre of the Earth as its Distance therefrom directly; but at Distances above the Earth, as the Square of Distance inversely.

‡ All Fluids will maintain an Equilibrium. Principia, V. II. p. 64.

§ The weight of bodies about the Earth are as the Square of their distances from the Earth's Centre inversely.

9. This Law of the Decrease of Gravity being demonstratively proved, and put past contradiction, the author with great sagacity enquired into the necessary consequences of this supposition, whereby he found the genuine Causes of the several Appearances in the Theory of the Moon and Planets, and discovered the Law of the Motion of Comets, and of the Ebbing and Flowing of the Sea.

10. All the surprising Phenomena of the Flux and Reflux of the Sea proceed from this Principle of Gravitation *.

11. If the Earth were not affected by the Actions of the Sun and Moon, it is not to be doubted, but the Ocean, being equally pressed by the Force of Gravity towards the Centre, would continue in a perfect Stagnation, always at the same height, without either ebbing or flowing: But it is demonstrated that the Sun and Moon have a like principle of Gravitation towards their Centres, and that the Earth is within the Activity of their Attractions, it will plainly follow, that the Equality of the Pressure of Gravity towards the Centre will thereby be disturbed; and tho' these Forces be small in respect of the Gravitation towards the Centre, yet the Ocean being fluid and yielding to the least Force; by its rising, shews, where it is less and where it is more pressed, by its rising and falling †.

12. Now if the Force of the Moon's attraction decrease as the Square of the distance from its Centre increases, we shall find that where the Moon is perpendicular either above or below the Horizon, either in the Zenith or Nadir, there the Force of Gravity is most of all diminished, and consequently that there the Ocean must necessarily swell by the coming in of the Water, from those parts where the pressure is greatest; viz. in those places where the Moon is near the Horizon, and under the opposite Meridian ‡.

I must desire to make the following Remark.

13. That is, At the Creation, suppose the Sun was placed in the Vernal Equinox, and the Moon in direct opposition in her Node in the Autumnal Equinox; by which the Sun enlightened the Earth by Day, and the Moon by Night, and the Moon having begun her diurnal and annual Motions: And by the Universal Law of Gravitation, given to the whole System of Bodies created, by the Creator; they began to act on each other, and in consequence thereof, by the Attraction of the Sun and Moon §, the Force of Gravity towards the Centre of the Earth was diminished, under opposite Meridians, and mostly so under their Zeniths; for those parts are most attracted that are nearest to the Sun or Moon, by which decrease of central Attraction, or Gravity, the Water would flow towards those parts under the Sun and Moon; and each Luminary would attract laterally, to 60 deg. from its Zenith: Consequently the fluid Earth, would be raised in opposite Parts, and depressed in opposite Parts, which is in the Horizon of the Sun and Moon: By this the spherical figure of the Earth became spheroidal. We are now to consider the effect of those Actions of the Sun and Moon, in respect of the Earth's Rotation on its Axis in 24 Hours; also in respect of the Motions of the Earth and Moon in their Orbs ||.

Remark, 2. The influence of the Moon in raising the Tides, is to that of the Sun, as 4,4815 to 1. Principia Lib. 3. Prop. 36 ¶.

By the motion of the Earth on its Axis [*], the longest Diameter of the fluid Earth, is not in direction of the Moon's Centre, for the whole mass of the Earth on its Axis being from West to

* Prin. V. II. p. 202. RULE 1. We are to admit no more causes of natural things, than such as are both true and sufficient to explain their appearances.

RULE 2. Therefore to the same natural effects, we must as far as possible, assign the same causes.

† Prin. p. 255. The Flux and Reflux of the Sea arise from the Actions of the Sun and Moon.

‡ Dr. Halley's Miscellanea Curiosa, p. 19.

§ Prin. p. 305, 307. Moon's Period. 29 d. 12 h. 44 m.

24
708.75 Hours.

* The mean daily Motion of the Moon Eastward, by which she passes the Meridian later each Day.

708.75 : 24 h. :: 24 h. : 48 m. 49 sec. *

¶ Eternity to the End of Time, or so long as the Earth revolves on its Axis, for Time is measured by the approach and recess of the Meridian to the Sun.

[*] Joshua, Ch. 10, v. 12. Remark. This might so happen, by divine Ordinance: But why so, for to serve the purpose of the Gibeonites.

to East, the most elevated parts of the Water will be towards the East of the Moon, in direction of the Earth's rotation.

14. Hence the Moon will always be to the West of the Meridian of the parts of the greatest elevation; which by calculation will be about 45 d. or 3 h.

15. Also since the Tides flow at the same time, under opposite Meridians, as at first propagated by the actions of the Sun and Moon, and the Earth revolving towards the East, endeavours to carry the raised Water with it; but the Attractions of the Sun and Moon, drawing it towards them, by which Force the Water flows towards the West; and these two Tides will keep flowing in such manner to Eternity *.

16. The Water being thus put in motion, will perpetually be so by the Rotation of the Earth, and by the Forces of attraction of the Sun and Moon: But if the Earth's Rotation was stopt, by which the Sun would appear to stand still, and Time to be at an End.—As said to be in the Days of Joshua, when the Battle was fought between the Gibeonites and the Amorites. "Sun, stand thou still upon Gibeon, and thou Moon in the Valley of Ajalon†." V. B. And the Sun stood still and the Moon stayed, until the People had avenged themselves upon their Enemies; is not this written in the Book of Joshua? So the Sun stood still in the midst of Heaven, and hastened not to go down about a whole day, v. 14. And there was no Day like that, before it, or after it, v. 17. The five Kings were found laid in a Cave at Mackedah.

Now granting this to be the Case, that the Sun and Moon apparently stood still, or that the Earth had no Rotation on its Axis for the space of a Day? What a confusion would the Inhabitants of the whole Earth be in! Those in the illuminated Hemisphere by seeing the Sun and Moon to stand still, and those in the nocturnal Hemisphere by having no appearance of Day for so long a Time.

17. It is not the Actions of the Sun and Moon only, that causes the Tides, but the inequalities of the Actions of each, which produce the effect. And when the Actions conspire together, as in the Change and Full of the Moon, when they are nearly in the same line with the Centre of the Earth, and therefore unite their Forces; so that the Tides are greatest, and are called Spring Tides: But the Action of the Sun, when the Moon is in her Quadratures, diminishes the Action of the Moon, because the one raises the Water in that Case where the other depresses it; and therefore the Tides are then least, and are called Neap-Tides.

18. The highest Tides are not on the Full and Change Days of the Moon, for this requires some Time after the greatest Force, to produce the greatest Tides, also the like for the Neap-Tides.

19. The high Water does not always answer to the same Position of the Moon, but happens sometimes sooner and sometimes later, as if the Moon only acted on the Water. This proceeds from the action of the Sun, which makes high Water sooner when the Sun alone would produce a Tide earlier than the Moon, which is the Case in the 1st. and 3d. Quarters of the Moon; but in the 2d and 4th Quarters, the Times of high Water is retarded, because the Sun alone would produce a Tide later than the Moon.

20. The different distances of the Moon from the Earth, produce likewise a considerable variation in the Tides. For the Force of the Moon increases as the Squares of the Distances decrease.

21. The Moon describes an elliptic Orb about the Earth, and produces a greater Tide at the least distance than at her greatest distance. Hence it is evident that the two Spring Tides succeeding each other, cannot both be high Spring Tides; for if the Moon be at her nearest distance from the Earth at the Change, she must be at her greatest distance at the Full, therefore the highest Spring Tide would be at the Change; and vice versa; the high Spring Tide being at the

* The Actions of the Sun or moon are unequal, and the parts of the Earth that are the nearest, are the most attracted.

† Luminary, any thing that gives Light.

‡ Lateral attraction, is that in direction of the Horizon of each Object i.e. Horizontal.

|| Horizon of any Place on the Earth, is the great Circle at 90 d. from the Zenith of that Place.

B. 3. Prop. 8. Cor. 1. The Weights of Bodies revolving in Circles about Planets, are as the Diameters of the Circles directly; and the Squares of their Periodic Times reciprocally.

the Full, the succeeding Spring Tide at the Change cannot be so great, because of the distance of the Moon being greater.

22. The effect of the Sun and Moon is greatest when in the Equinoctial; for then the Axis of the spheroidal figure arising from their actions, moves in the greatest Circle, and the Water is put into the greatest agitation: Hence the Spring Tides produced when the Sun and Moon are in the Equinoctial, are the greatest of any; and the Neap-Tides are the least which happen when the Sun and Moon have their greatest Decline. Because the Sun is nearer the Earth in our Winter, than in Summer, therefore the greatest Spring Tides are after the Autumnal and before the Vernal Equinox.

23. Since the Tides depend more upon the Action of the Moon than that of the Sun, they are therefore greatest when the Moon's Action is greatest.

24. When the Moon declines towards either Pole, one of the greatest Elevations of the Water follows the Moon, and describes nearly the parallel on the Earth's Surface, which is under the diurnal Arch of the Moon; and the opposite Elevation of the highest part of the Tide will be in or near the Antipodes of the other Tide, which will be as much on the other side of the Equator.

Consequently if a place is on the same side of the Equator with the Moon, the Day Tide, or that which is produced while the Moon is above the Horizon of the place, will exceed the Night Tide; or that which is produced while the Moon is under the Horizon.

Likewise if the Sun and Moon both describe the Tropic, of the same Name as the Latitude, the Tides will be augmented; but if they are in the opposite Tropics, the Tides will be diminished.

25. By observation, the Evening Tides in the Summer exceed the Morning Tides, and the Morning Tides in the Winter exceed the Evening Tides: For in the Summer the Sun raises the Tides following his Zenith, to the N. of the Line, and the opposite Tide, to the S. of the Line, they are highest; & the Contra in the Winter.

The difference of those Evening and Morning Tides are found at Bristol to be 15 Inches and at Plymouth 12.

26. That the Tides may have their full motion, the Ocean in which they are produced ought to be extended from East to West, at least 90° . or $\frac{1}{4}$ of the Equator; because the places where the Moon raises and depresses the Water the most, are at that distance from each other. Hence the Tides in the Pacific Ocean, exceed those in the Atlantic Ocean. Also it is Obvious why the Tides are not so great in the Torrid Zone, between Africa and America, where the Ocean is narrower, as in the temperate Zones on either side; and from this also we may understand why the Tides are so small on the Coasts of Islands, that are far distant from the Shores of Continents. It is manifest, that, in the Atlantic Ocean, the Water cannot rise on one Shore, but by descending on the other; so that at the intermediate distant Islands, it must continue at a mean height betwixt its Elevation on one Shore and on the other.

27. The Tide that is produced on the Western Coast of Europe, in the Atlantic, corresponds to the situation of the Moon: Thus it is high Water on the Coasts of Spain, Portugal and the West of Ireland, about the 3^d hour after the Moon has passed the Meridian; and from thence it flows into the Adjacent Channels, as it finds the easiest Passage.

One Current from it runs up by the South of England, another comes along the Coast of Scotland: And while it is flowing in one place, it is ebbing in another. The Tide takes 12 Hours in coming from the Ocean to London-Bridge.—So that, when it is High Water at London, a new Tide is come to its height in the Ocean; and in some intermediate place, it must be Low Water at the same Time.

Our Author (Dr. Halley) also observes, that when the Tide runs over Shoals, and flows upon flat Shores, the Water is raised to a greater height than in the open and deep Oceans that have steep Banks; because the Force of its Motion cannot be broke upon these level Shores, till the Water rises to a greater height. If

B. 3. Prop. 6. Cor 5. The Power of Gravity, is of a different Nature from the Power of Magnetism. For the magnetic Attraction is not as the Matter Attracted. The magnetic Attraction is not as the Square, but as the Cube of the distance reciprocally, or very nearly.

28. If a place communicates with two Oceans, one of which has a readier and easier Passage than the other; two Tides may arise at that place at different times, which interfering with each other, may produce a great variety of appearance. And by which there may be produced two ebbs and two floods for each Tide.

For instance, at Batsha, a Port in the Kingdom of Tunquin in the East Indies, whose Latitude is $20^{\circ}.50'$ North; the Day in which the Moon passes the Equator, the Water there stagnates; and as the Moon begins to decline from the Plane of the Equator, the Water begins to rise and fall once a Day; and it is High Water at the setting of the Moon, and Low Water at her rising. This daily Tide increases for about 7 or 8 Days, and then decreases for as many Days: And when the moon has passed the Equator to the Southward, the Tide begins again to flow, and produces High Water at her Rising and Low Water at her Setting. Our Author* accounts for this extraordinary tide, by the two Inlets to this Port; one from the Chinese Ocean, betwixt the Continent and the Manillas, and the other from the Indian Ocean, betwixt the Continent and Borneo (whence the Solution) that a Tide may arrive at Batsha through one of these Inlets at the third Hour of the Moon, and another through the other Inlet at the ninth Hour of the Moon: For while these Tides are equal, the one flowing in as the other ebbs out, the Water must stagnate for some Time; and they are equal when the Moon is in the Plane of the Equator: But as soon as the Moon begins to decline on the same side of the Equator with Batsha, the diurnal Tide must exceed the nocturnal one; so that two greater and two lesser Tides must arrive at Batsha by turns, and the Difference of these two will produce an Agitation of the Water, which will rise to its greatest height at the mean time betwixt the two greatest Tides, and fall lowest at a mean time betwixt the two least Tides; so that it will be High Water about the Change Hour, at the Setting of the Moon, and Low Water at her Rising.

When the Moon has got to the other side of the Equator, the nocturnal Tide will exceed the diurnal, and therefore the High Water will be at the Rising, and Low at the Setting of the Moon.

Observe, the like Cause in all other Cases of this nature will produce like Effects.

29. Since the Sun and Moon attract the Earth in the Ratio of 1 to $4\frac{1}{2}$ nearly, which is their separate effects of raising the Tides; whence the sum and difference of their effects are as $5\frac{1}{2}$ to $3\frac{1}{2}$ nearly; therefore their greatest joint effects can never exceed 11 feet in the alteration of the height of the surface of the Water in the Sea; but in Channels and Rivers, by its running some hours up them, it may rise two or three times that height or more by such progressive motion before it be retarded.

30. The height that Spring Tides flow at Dover, Deal, Harwich and at Hull, is from 20 to 24 feet; and Neap Tides about 12 feet.

31. A very slow and imperceptible motion of the whole body of the Water, where it is 2 miles deep, will suffice to raise its surface 10 or 12 feet in a Tide's time; whereas, if the same quantity of Water were to be converted up a Channel of 40 fathoms deep, it would acquire a very great Stream to effect it: Whence the Tide is found to set strongest in those places where the Sea is narrowest, the same quantity of Water being to pass through a small passage: This is evident in the Streights between Portland and C. de Hague in Normandy, where the Tide runs like a sluice.

32. The Tides in the port of Tunkin in China, which are so extraordinary, having but one Flood and Ebb in 24 hours; and when the Moon is near the Equinoctial there is no Tide at all†.

* Dr. Halley's Miscel. p. 23.

† Sir I. Newton attributes the Cause to be from the Concurrence of two Tides, the one propagated in six hours out of the great South Sea, along the Coast of China; the other out of the Indian Sea, from between the Islands, in twelve hours, along the Coast of Malacca and Cambodia.

OF THE TRADE WINDS AND MONSOONS.

A TRADE Wind, is the Wind that blows always the same way, or from the same Point of the Compass, or nearly so.

A Monsoon is a periodical Wind. Hence;

Monsoons are shifting Trade Winds which are in the (East) Indian Ocean and Seas, which blows periodically, some for half a Year one way, and the other half Year the other way. Others, but for three Months, and then shift and blow directly the contrary way for the same time; and so on alternately and interchangeably.

An exact Account of the constant and periodical Trade Winds, observable in several parts of the Ocean, is a part of Natural History, not less desirable and useful than its difficult to obtain, and its Phenomena hard to explain*.

The universal Ocean may properly be divided into three Parts.

1. The Atlantic and Ethiopic Sea. 2. The Indian Ocean. 3. The great South Sea, or the Pacific Ocean: And though these Seas do all communicate, by the South, yet they are sufficiently separated by the interposition of great Tracts of Land.

In the Atlantic and Ethiopic Seas, between the Tropics, there is a general Easterly Wind all the Year long without any considerable variation; but subject to be deflected a few points towards the North or South according to the position of the place.

These Deflections are as follow:

1. Near the Coast of Africa, as soon as you have passed the Canary Isles, you are sure to meet a fresh Gale of N. E. Wind, about the Latitude of 28 d. N. which seldom comes to the Eastward of the E. N. E. or passes the N. N. E. This Wind accompanies those bound to the Southward, to the Lat. of 10 d. N. and about 100 Leagues from the Guinea Coast; where to the 4th degree of N. Lat. they fall into Calms and Hurricanes†.

Those bound to the Caribbee Isles, finding as they approach the American side of the Atlantic Ocean, that the N. E. Wind becomes more and more Easterly, so as sometimes to be E. or E. b. S. but mostly a Point or two to the North of the East; and it is likewise observed, that the Strength of these Winds do gradually decrease as you sail to the Westwards.

The Limits of the Trade and variable Winds in the North Atlantic are further extended on the American side than the African; for near the Coast of America it holds to 31 or 32 d. North; and the like to the South of the Line‡.

From the Lat. of 4 d. N. to the Lat. of 30 S. the Winds are generally and perpetually between the S. and the E. and most commonly between the E. and S. E. but on the African side they are more Southerly, and on the Brazilian more Easterly, so as to become nearly due E. the little Deflection they have being Southerly§.

The season of the Year has some small Effect on these Trade Winds, for when the Sun has a considerable declination N. the S. E. Winds, especially between Brazile and the Coast of Guinea, do vary a point or two to the Southwards; and the N. E. Trade becomes more Easterly: And, on the contrary, when the Sun has about 20 d. of South decl. the S. Easterly Winds become more Easterly, and the N. Easterly Winds on the N. of the Line veer more to the Northwards.

That as there is no general Rule that admits not of some Exception, so there is in this Ocean a Tract of Sea wherein the S. W. Winds are perpetual, viz. All along the Coast of Guinea, for

* Varenus, General Geography, B. I. Ch. 21. Many have in vain endeavoured to account for these.

† Tornadoes or Hurricanes.

‡ Like Causes produce like Effects.

§ Dr. Halley says in p. 63, 64. that in the Southern Part of this Ocean, he has passed a full Year and found the Winds constantly about the S. E. and S. E. by E. but when E. it generally blew hard.

for above 500 Leagues together*, from Sierra Leona to the Isle of St. Thomas: For the South East Trade Wind having passed the Line and approaching the Coast of Guinea, within 80 or 100 Leagues, inclines towards the Shore and becomes S. S. E. and as you come nearer to the Shore, it veers about to the S. and S. S. W. and in with the Land, S. W. and sometimes W. S. W. there are sometimes Calms, and other times Tornado's from all Points of the Compass †.

To the Northwards of the Line between 4 and 10 d. of Lat. N. and between the Meridians of Cape Verd and of the Eastermost of the Isles of that name, there is no Trade Wind, or yet a variable Wind, it being mostly calms ‡, attended with terrible Thunder and Lightning and Rains. There are Breezes from different Points which soon die away.

In the Months of July and August Ships find a Difficulty to pass to the Southward, because of the S. E. Winds, extending some Degrees beyond the usual limit of 4 d. N. which Winds blow sometimes from the South.

Being in with the African Coast, the Wind generally blows at S. W. and W. S. W. with which Winds, Ships make to the Southward, and then get a S. Easterly Wind, by which they make the Gold Coast and the Island of St. Thomas §.

For the sake of these general Winds, all those who use the West India Trade, and some bound to Virginia count it the best Course ||. But homewards bound from America, makes the Lat. of 32 d. N. as soon as possible, where they find the Winds begin to be variable; and then they generally soon get a S. W. Wind ¶.

Near the Shore the Winds vary both in Force and Direction, from the Situation of Mountains, Vallies and Woods, as also from the Texture of the Soil, being more or less capable of condensing Vapours, or of reflecting Heat. Water and marshy Land condenses, but sandy, chalky and Lime-stone reflects.

1. In the Indian Ocean, between the Lat. of 10 and 30 d. S. which is between Madagascar and New Holland, the general Trade Wind about the S. E. by E. is found to blow all the Year long.

2. The S. E. Winds extend to within 2 d. of the Equator during the Months of June, July and August and to November, at which time between 2 and 10 d. S. near the Meridian of the N. end of Madagascar, and between 2 and 12 d. S. near Sumatra and Java, the contrary Winds from the N. W. or between the N. and W. set in and blow for half the year, from the beginning of December till May, and this Monsoon is observed as far as the Molucca Isles ¶.

There is another Monsoon from 3 d. S. over the whole Arabian or Indian Sea and Gulf of Bengal, from Sumatra to the Coast of Africa, blowing from October to April N. E. but from April to October upon the opposite Point S. W. or W. S. W. and rather stronger than the other. These Winds in these Seas are generally more Southerly on the African side, more Westerly on the Indian.

Between the African Coast and Madagascar, and as far as the Line, from April to October, there is a constant fresh S. S. W. Wind, but as you go more Northerly, the Wind becomes more Westerly, so as to fall in with the W. S. W. Wind.

To the Eastward of Sumatra and Malacca, to the North of the Line, and along the Coast of Cambodia, Camboia and China, the Monsoons blow N. and S. that is to say, the N. E. winds are much Northerly, and the S. W. much Southerly (*). This reaches Eastwards of the Philippine Isles, and as far as the Isles of Japan to 40 d. North. The Northern Monsoon sets in, in October or November, and the Southern in May, which blows all the Summer Months.

Note,

* 30° = 25 d. the Wind comes from the Sea towards the Land, S. S. W. and S. W. from the Lat. 8 d. North along the Coast of Guinea, the Gold Coast.

† Calms at 80 Leagues from the shore contain about 6 d. of Lat. Ships in sailing these are frequently a month.

‡ The Sea of perpetual Calms contains about 6 d. of Lat. and 6 d. of Lon. Ships in sailing these are frequently a Month.

§ Guineamen sail E. S. E. till they fall in with the Coast of Guinea.

|| The West-Indiamen, Carolina and Virginia Ships outwards.

¶ Molucca Isles about 25 d. East from the Straits of Malacca.

(*) Canton, $23\frac{1}{2}$ d. N. 112 d. E. Pekin 40 d. N. Lat. Metropolis of China.

Note, That the end of the Westerly Monsoon on the Coast of Coromandel, and the two last Months of the Southerly Monsoon in the Chinese Seas are subject to be tempestuous; they are violent, much like the West India Hurricanes, and render the Navigation of these parts very unsafe about that time of the year; with this difference that the Northerly is towards the N. W. and the Southerly towards the S. E. and the change about a month or 6 weeks later.

They are termed by our Seamen, 'The Break-up of the Monsoons,'

To assign the Cause.

1. Why these winds are perpetually from the E. in the Atlantic and Ethiopic as likewise in the Pacific Ocean, between the Latitudes of 30 d. N. and S.
2. Why these winds extend no further than 30 d. N. and S.
3. Why there should be a constant Southerly wind upon and near the Coast of Guinea.
4. Why in the N. point of the Indian Ocean the winds should change and blow from the opposite point the other half year.
5. Why to the North of the Equator the wind should blow from the Northward of the E. and to the S. of the Equator from the Southward of the East.
6. Why in the Chinese Seas there should be so great an Inclination from the E. to the N. more than elsewhere, all which are much easier proposed than answered.

Wind is most properly defined to be the Stream or Current of the Air; and where such a Current is perpetual and fixt in its Course; it is necessary that it proceed from a permanent unintermitting Cause*: Wherefore some have been inclined to propose the diurnal Rotation of the Earth upon its Axis, by which, as the Earth turns Eastwards, the loose and fluid particles of the Air, being so exceeding light, that they are left behind; so that in respect of the Earth's Surface they move Westwards, and become a constant Easterly wind. This opinion seems confirmed, for that these winds are found only near the Equator, in those Parallels of Latitude where the diurnal Motion is swiftest; and we might readily assert to it, if the constant Calms in the Atlantic Ocean, near the Equator; the Westerly winds near the Coast of Guinea; and the Periodical Westerly Monsoons, at the Equator in the Indian Seas, did not declare the insufficiency thereof; besides, the Air being kept to the Earth by the principle of Gravity, would acquire the same degree of velocity that the Surface of the Earth moves with, as well in respect of the diurnal Rotation as of the annual round the Sun, which is about 30 times swifter.

It now remains to substitute some other cause capable of producing a like constant Effect, agreeable to the known properties of the Elements of Air and Water, and the Laws of the Motion of fluid Bodies.

1. Such a cause, we may conceive, to be the Action of the Sun's beams upon the Air and Water, as it passes every day over the Oceans, considered together with the nature of the Soil and situation of the adjoining Continents. Therefore according to the Law of Statius, the Air which is less rarified or expanded by heat, and consequently more ponderous, must have a motion towards those Parts thereof which are more rarified and less ponderous, to bring it to an Equilibrium.—2. That the Presence of the sun being Westwards continually, that part towards which the Air tends, by reason of rarification made by its greatest meridian heat, is with the Sun carried Westwards, and consequently the whole tendency is that way.—3. Thus a general Easterly wind is formed, which being impressed upon all the Air of a large Ocean, the parts impel one another, and so keep moving till the next return of the Sun, whereby so much of the Motion as was lost is again restored, and thus the Westerly wind is made perpetual †.

4. From the same principle it follows, that this Easterly wind should on the North side of the Equator be to the Northwards of the East, and in South Latitudes to the Southwards of the East: For near the Line the Air is much more rarified than in any other place; because the Sun is twice a year vertical to all places within the Tropics, and its distance from the Line, never exceeds $23\frac{1}{2}$ d. but from the Tropics, it recedes 47 d. once a year, and then makes

Winter

* A durable and unmixed Cause.

† Easterly and Westerly Winds produced.

‡ Parts of the Earth nearest the Equator are heated the most.

Winter with them; wherein the Air so cools, as that the Summer heat cannot warm it to the same degree as that at the Equator. Wherefore the Air to the Northwards and Southwards, being less rarified than that in the middle, it follows that from both sides it ought to tend towards the Equator in conformity to this cause, which observations have shewn to be so*. And this motion compounded with the former Easterly wind, answers all the Phænomena of the general Trade Winds, which, if the whole surface of the Earth was Water, would inevitably blow all round, as they are observed to do in the Atlantic Ocean.

But the interposition of great Continents break the continuity of the Oceans, together with the nature of the Soil, and the positions of high Mountains, may justly be taken for the causes of the several variations of the winds, from the above: For, a Continent lying nearly under the Sun, being flat, sandy, low land, such as the Deserts of Lybia† are said to be, so that the heat occasioned by the Reflection of the Sun's beams, and the retention thereof in the sand, is incredible to those who have not felt it, the dense Air flowing in to restore the Equilibrium; from the Seaward, near the Coast of Guinea, where the wind always sets in upon the land, blowing Westerly‡. There is sufficient reason to believe that the inland parts of Africa are prodigious hot, since the Northern borders thereof were so intemperate as gave the ancients cause to conclude, that all beyond the Tropic was made uninhabitable by excess of heat. From the same cause it happens, that there are such frequent calms in that part of the Ocean, and by nearly perpetual and constant Calms and frequent Rains, it is called the Rains; this tract lies in the middle between the Westerly and Easterly winds, and the Air being there in a state of Equilibrium between them§; and the weight of the incumbent Atmosphere being diminished by the continual contrary winds blowing from thence, is the reason that the upper air there has a currency downwards||, whereby the vapours being jumbled together, cohere, and thereby compose the drops of the showers of Rain¶; and this is the reason why the Air in that Sea cannot support the vapour it receives, but lets it fall by frequent showers. But as the cool and dense Air, by reason of its greater gravity, presses upon the hot and rarified, so that the hot Air must ascend, and in a continual stream as fast as it rarifies(*); and that being ascended, it must disperse itself to preserve the equilibrium; and that by a contrary current, for the upper air must move from those parts where the greatest heat is: So by a kind of circulation the N. E. trade wind below, will be attended with a S. Westerly wind above(†); and the S. Easterly with a N. Westerly wind above. This is confirmed by the Monsoons, and experience has shewn the sudden change of the wind to the opposite point which is frequently found in passing the limits of the trade wind.

Supposing such a circulation, as before recited, to the Northward of the Indian Ocean, where there is every where land within the Limits of 30 d. Lat. viz. Arabia, Persia, India, &c. which for the same reason as the Mediterranean parts of Africa are subject to excessive heats(‡), when the Sun has a considerable N. declination: But when the Sun returns to the Southward (S. decl.) the Air becomes cold especially over the ridge of mountains at some distance within the land, which are frequently covered with snow in winter, over which the air, as it passes, must needs be much chilled. Hence the Air coming, according to the general rules, out of

D

the

* The Wind tends towards the Equator, from 30 d. Lat. N. and S.

† Lybia is West of Egypt

‡ Westerly nearly West. The Wind blows W. i. e. from the West, occasioned by the greater rarification of the Air on the Land.

§ That is, between the Winds.

|| The upper Air sets downwards.

¶ Calms and Rains almost constant.

(*) Hot Air ascends as fast as it rarifies.

(†) Winds, the upper and lower blow different ways.

(‡) Natural effects of the same kind are owing to the same causes. Sir Isaac Newton's Principles.

the N. E. from the Indian Seas, is sometimes hotter, sometimes colder than that by the circulation is returned out of the S. W. and, by consequence, sometimes the under current of the Wind is from the N. E. sometimes from the S. W.

That this has no other cause, is evident from the times these winds set in, viz. April; when the Sun begins to warm those countries to the North, the S. W. Monsoon begins, and blows till October; when the N. Latitudes grow cooler and the Southern hotter; when the N. E. Monsoon begins and blows till April: And from the same principle to the South of the Equator, in part of the Indian Ocean, the N. W. winds succeed to the S. E. when the Sun draws near the Southern Tropic.

Note, In the Ethiopic Ocean there is a S. E. wind all the year.

It is very remarkable that the Trade winds should be fixed to the limits of 13 d. of Lat. all round the globe.

And that in the Indian sea, only the Northern part should be subject to the changeable Monsoons, and in the Southern, there should be a constant S. E. wind*. These particulars merit to be considered more at large by those who are accustomed to philosophic contemplation.

Remark, That the Andes are mountains which run N. and S. almost the whole length of S. America, through the Countries of Peru and Chili, parallel to, and but a little distance from the Pacific Ocean, esteemed the highest land of the Earth, and they are covered with snow in the warmest climates†.

A moderate gale of wind has a velocity of about 15 miles an hour; whereas the Doctor‡ concludes, that the very great storm in November 1703, might be between 50 and 60 miles, the swiftest velocity in a great storm.

The velocity of sounds, by various experiments, at a mean is 1142 feet in one second of time; but by Mott's Newton's Principia, p. 182, by calculation, sound flies 1088 f. in a second. If the atmosphere consist of 10 parts of true air and 1 of vapours, the motion of sounds will be swifter in the subduplicate ratio of 11 to 10, or very nearly in the entire ratio of 21 to 20; by this means the sound will pass through 1142 f. in one second of time§.

These velocities will be found true in Spring and Autumn, but when the Air is more rarified, as it is in Summer by the Sun, the velocities will be greater; and in the Winter, it will be less; as the velocity depends on the elastic force of the Air.

An estimate of the quantity of vapours raised out of the Sea, derived from experiment, by Dr. Ed. Halley||. He says, We took a pan of coals and put it under a pan of water about 4 inches deep and $7\frac{9}{16}$ diameter, in which we placed a Thermometer, and the water being a little heated, we brought it to the same degree of heat as the air in Summer; the pan of coals and water were placed in one end of a balance, and weights in the other scale of the balance; and we kept the water in the same degree of heat, by removing the pan of coals at pleasure. At the end of two hours we found the water had evaporated half an ounce, Troy: wanting only 7 grs. though one could hardly perceive it smoke. I shall assume, as Dr. Bernard, that a cubic foot of water weighs exactly 76 lb. Troy; which divided by 1728, gives $253\frac{1}{3}$ grs. or $\frac{1}{2}$ oz. and $13\frac{1}{3}$ grs. the weight of one cubic inch of water. Hence we find that $\frac{1}{60}$ of an inch depth of water was evaporated in 2 hours; therefore in 12 h. it exhaled $\frac{1}{10}$ of an inch; which quantity will be sufficient to account for all the rains, springs and dews, that happen, when the large surface of seas, rivers and lakes are considered.

The Caspian sea being always at a stand, neither wasting nor overflowing; as likewise for the current that sets in at the Streights of Gibraltar, though those Mediterranean seas receive so many, and such considerable rivers.

Now

* Dr. Halley's Account, p. 79. If 10 square inches yield $\frac{1}{2}$ oz. 144 will yield 7,2 oz. per day.

† Salmon's Gazetteer.

‡ Dr. Derham measured the velocity of the wind in that great storm which happened the 11th of August 1705, was 33 feet per half second, or 45 miles per hour.

§ 1142 feet English, or 1070 feet, French.

|| Miscellanea Curiosa, p. 1. And $231 \times 1728 (7\frac{1}{2} \text{ gallons in one solid foot, B } 7,5) 76,0 (10 \text{ lb. Troy. per gal.}$

Now if 10 square inches of the surface of Water yield 1 cubic inch of water per day, and each square foot half a pint *, and every space of 4 feet square half a gallon, then a mile square would yield 6914 tons; hence a degree square, or 60 English miles would evaporate 33 millions of tons. And if the Mediterranean contains 160 degrees sq. of sea, it must lose in vapour, in a Summer's day, at least 5280 millions of tons, besides what the winds take up, which sometimes is more than it is exhaled by the heat.

The Mediterranean receives the following rivers, viz. 1. The Iberus. 2. The Ront. 3. The Tiber. 4. The Po. 5. The Danube. 6. The Niester. 7. The Borystenes. 8. The Tanais. 9. The Nile. These 9 rivers, with the Rivulets, we may suppose, bring into that sea 10 times as much as the river Thames.

Of SPRINGS, RIVULETS and RIVERS†.

VAPOURS raised from the sea, and by the wind carried over the low lands, to the ridges of mountains, and compelled to mount up with the stream of the air to the tops where the water presently precipitates gleeting down by the chinks and clefts of the stones, and part of the water entering into the caverns of the hills, the water thereof gathers into basons of the stones it finds, which being once filled, it begins to run over by the lowest place, of each of these basons, and breaks out by the side of the hills into springs †; many of those make a rivulet, and several rivulets make a river, &c. And thus it happens, that the rivers do not send so much water into the Mediterranean as are exhaled from it.

IN the latter end of the First Vol. of the Miscellania, is a discourse concerning the action of the Sun and Moon on animal bodies, and the influence they may have in many diseases, by R. Mead, M. D. and F. R. S. 1. That some diseases are properly the effects of the influence of the heavenly bodies. 2. That the most windy seasons of the year are about the vernal and autumnal equinoxes. 3. All the changes we have enumerated in the Atmosphere do fall out at the same times when those happen in the ocean; and as both the waters of the sea and the air of our earth, are fluids, subject in a great measure, to the same laws of motion; so that natural effects of the same kind are owing to the same causes.

4. The alteration made by the Sun and Moon in the Atmosphere, must thereby have influence on the animal body.

5. The elasticity of the air is of great moment, and it is reciprocally as the pressure, so that the incumbent weight being diminished by the attraction, the air underneath will be much expanded: These and such like causes will make the Tides in the air to be much greater than those of the ocean; and there is no doubt to be made, but that the same infinite wise Being, who contrived the flux and reflux of the seas, to secure that vast collection of waters from stagnation and corruption, has ordered this ebb and flood of the air of our Atmosphere, with the like good design, that is, to preserve it sweet, and a brisk temper of this fluid so necessary to life; by a continual circulation.

6. Two contrary winds blowing towards the same place, may accumulate the Air there, so as to increase the height and the weight of the incumbent cylinder; in like manner, the direction of two winds may be such, as meeting at certain angles, may keep the gravity of the air in a middle state; but if the winds blow different ways from the same place, (which may be occasioned by thunder and lightning) the height and weight of the air may be much decreased.

7. The changes in our Atmosphere at H. Water, new and full Moon, the Equinoxes, &c. must occasion alterations in all animal bodies: For all living creatures require air of a determined gravity to perform respiration easily; for it is by its weight that this fluid insinuates itself into the cavity of the breast and lungs: By a slow circulation the secretion of the spirits is diminished: And, by the want of force of elasticity and gravity, the juices begin to ferment, change the union of the parts, break their canals, and diseases follow.

Of

* Wine measure

† Miscellania Curiosa, p. 9. Troy 10 lb. = 120 oz. If 7 oz. require 1 foot square, 120 oz. will require 17 square feet for 1 gallon per day.

‡ The Ridges of Hills serve as Alembicks to distill fresh water for the use of man and beast.

Of the BAROMETER, by Dr. HALLEY*.

THE elastic property of the air has been proved by experiments, and the resistance of its spring is found to be nearly equal to the weight or force that compresses it; as also that the spaces the same air occupies, under different pressures, are reciprocally as those pressures: It has been shewn by experiment, that the specific gravity of the air, near the earth's surface, to that of water, is as 1 to 840 nearly; the Mercury standing at $29\frac{1}{2}$ inches: But as these experiments were made in Summer, when the air was heated, we may without sensible error take 30 inches for the height of the Mercury in a mean state of the air*, and the specific gravity, as 1 to 800. By the like trials, the weight of Mercury to water, is as $13\frac{1}{2}$ to 1, or very near†; so that Mercury is to air, as 10800 to 1; and a cylinder of air 10800 inches, or 900 feet, is equal to an inch of Mercury; and were the air of an equal density like water, the whole Atmosphere would be only $5\frac{1}{9}$ miles high‡; for the expansion of the air increases in the same proportion as the incumbent weight of the Atmosphere decreases; that is, as the Mercury in the Barometer sinks, So that the Atmosphere must be extended to a much greater height. Now, upon these principles, to determine the height of the Mercury at any assigned height in the air, and the contrary; having the height of the Mercury given, to find the height of the place; are problems not more difficult than curious, and which I thus resolve.

The expansions of the air being reciprocally as the heights of the Mercury, it is evident, that by the help of the hyperbolic curve and its asymptotes, the said expansions may be expounded to any given height of the Mercury§.

The hyperbolic areas design the tabular logarithms, being 0,0144765; whence it will be, as, 0144765 : 900 feet :: the difference between the log. of 30, or other number of the height of the Mercury at the bottom, and those corresponding to the inches of the height of the Mercury at the top of the mountain: the height of the Barometer above the bottom or base of the mountain. Ex. Suppose the Mercury in the Barometer be 30 inches high, upon a level with the surface of the sea, and in the like state of the air, on the top of a mountain it stand at 28 inches; what is the height above the surface of the sea?

Thus, Log. of 30 = 1,477121
Log. of 28 = 1,447158

As 0,0144765 : 900 :: 0,029963 : 1862 feet, the height of the mountain ||.

Suppose the Barometer 30 at the Base, and 20 inches at the top of a mountain, what is the height? Log. of 30 - Log. of 20 =,176091

× 900 feet m. yards
14476 | 158481900 (10947 + = 2 129.

Upon these suppositions, it appears, that at the height of 41 miles, the air is so rarified, as to take up 3000 times the space it occupies here; and at 53 Miles high it would be expanded above 30000 times; but it is probable that the utmost power of its spring cannot exert itself to so great an extension, and that no part of the Atmosphere reaches above 45 miles from the surface of the Earth.

This seems confirmed from the observations of the Crepusculum, which is observed to begin and end when the Sun is about 18 degrees below the Horizon; for supposing the Air to reflect light from its most rarified parts; and that as long as the Sun illuminates any of its atoms, they

* Miscellania Curiosa, p. 81.

† Mean state of heat and cold.

‡ Air to Mercury, as 1 to 800 × $13\frac{1}{2}$ = 10800.

§ $\frac{30 \times 900}{5280} = 5\frac{1}{9}$

|| See Miscel. page 82, and following.

¶ By Bouguer's Table, the fall = 290 toises = 1854 feet.

they are visible to an eye, not intercepted by the curvity of the Earth, till the ratio of the height reflected from, be to the semidiameter of the Earth as 1 to 90, or as the secant of about $8\frac{1}{2}$ degrees to the radius.

See Waddington's Treatise of the Longitude, Plate I. Fig. 3. Where let E be the place of the eye of the Observer, *f* the place where the Sun sets when twilight ends at E, and the arch of the angle ECA = AC*f*, the sum = 18° ; also the excess of the secant of ECA, above the radius = aA, will be the height of the atmosphere. But the ray of the Sun, at A, has suffered a double refraction, nearly; and in coming from thence to E, it will be more refracted about 33 minutes, in a mean state of the Air; hence it is evident that the ray when it arrives at E, has been refracted near three times the quantity of the horizontal refraction, or $3 \times 33' = 99' = 1^\circ.39'$: And since by observation of the time, that the twilight can be seen after Sun-set, the depression of the Sun below the true Horizon, by calculation, is about 18° ; and the refraction of the ray being subtracted, leaves $16^\circ.21'$, its $\frac{1}{2}$ is $8^\circ.10\frac{1}{2}'$, the secant of which above the radius is $(1.010266 - 1.000) = .010266$; and $.010266 \times 4000$ the radius is = 41.06 miles, the height of the Atmosphere, from which we can see reflection.

Dr. Halley takes only 1° for double the horizontal ref. from 18° and there remains 17° , its $\frac{1}{2}$ is $8\frac{1}{2}$, whose secant is 1.011106. $- 1 = .011106 \times 4000 = 44.424$ miles, the height of the Atmosphere. The rad. of the Earth, supposed to be 4000 miles. A curious experiment was made by Mr. J. Coswell of Oxford, upon the top of Snowden Hill in Carnarvanshire, which seems to prove, that the first inches of Mercury have their portions of air near enough to what I now determine: For the height of the hill being 1240 yds. or very near it, he found the Mercury to have subsided to 25.6 inches, or 4 inches below the mean altitude at the level with the Sea; the space by the Doctor's calculation comes out 1288 yards: By Bouguer's table, we shall have $4 \times 11,263 = 45,05$ lines = 3 i. 9 l. gives 623 toises, $\times 6,392 = 3982$ feet, = 1327 yards English. Note, 11,263 lines = 1 inch Eng. and 1 toise = 6,3925 feet English.

OF M A G N E T I S M.

HOW long it is since the Magnet * or Loadstone has been taken notice of, and distinguished from other mineral stones, is not known: It has been frequently mentioned since the time of Plato †; and several attempts have been made to solve its appearances.

The Knowledge of its properties were little known for a long time, more than its attractive quality, to other Magnets, and to iron: While its directive power, disposing its poles nearly in direction of the Meridian of most places were unknown: And that needles and long pieces of iron and steel touched by it, became Magnetical; also when suspended they would turn themselves in direction North and South. This property was found out at the End of the 13th Century. It is said, that Paulus Venetus made a Mariner's Compass about the year 1260, and applied it to the use of navigation ‡; but not as an invention of his own, having derived it from the Chinese. But the learned Renaudat has given reasons that the Chinese took it from the Europeans.

Anno Dom. 1300, John Goia, a Neopolitan, is generally allowed to be the first who applied it to the guidance of a Ship in the Mediterranean. Dr. Wallis said, "Where inventions creep in by degrees, it must be thought strange, that it was not noted who was the first inventor. In

D

" the

* Magnet, F. Magnes, and Magnetism. F. Magnet.

Power of the Loadstone, Power of Attraction.

† Plato died in the first year of 108th Olympiad, and in the 81st year of his age.

The Olympiads began 776 years before Christ. Each Olympiad contains 4 years.

Years before Christ 776

$108 \times 4 = 432$

Years before Christ 344 Plato died.

‡ Anno 1774.

§ A Compass made in 1260.—Hence it is 514 years since the Compass has been in use.

“ the present case, he who first observed the Polarity of the Magnet, or its inclination and “ meridian direction, made the first step towards this invention.”

Dr. Wallis* claims the Invention to the English, from the English name, Compass and Box or Boxel; which are imitated by most other nations used to navigation.

The Magnes or Magnet is found in divers parts of the earth, and commonly in iron mines. Pliny said, It was called Magnes from the name of the person who first found it, and he was a herdsman in the East Indies†.

The first and best Loadstones came from China and Bengall: And it is commonly a sole stone lying by itself in the earth‡. There are some found in Arabia, and in the Red Sea, and some are found in Norway.

The Chinese, in the year 1597, steered by a needle 6 inches long, upon a Pin, in a dish of white china, filled with water, in the bottom of the dish they had two cross lines, for the N. S. E. and W. winds, the rest was left to the judgment of the artist§.

In the year 1500, Sebastian Cabot, a Venetian, is generally allowed to be the first who discovered the variation of the Needle, from pointing North and South; and that the variation was real||.

But Mr. Norman and Mr. Burrows were the exact observers of the variation¶ and inclination; and that the variation was different in different countries and places

Mr. Gillibrand first discovered the variation of the variation (*), about the year 1625, when by a needle executed in privy garden, Whitehall, he found the variation to be

in June, 1665 = $1^{\circ}.22'.30''$ W.

— 1666 = $1^{\circ}.35'.36''$

The Needle was 3 feet long.

The increase in a year, = $0^{\circ}.13'.06''$

About the year 1663, Mr. H. Bond embraced a Hypothesis of moveable magnetic poles, and supposed them in or about our Atmosphere, and from that motion which he supposed to be Westward, and to make a revolution in 600 years, he computed a table of the variation of the Needle for London, from the year 1663 to 1715, which was inserted in the Philos. Transactions, No. XL. and which agreed pretty well till the year 1700(†)

The times of oscillation and vibration in Dipping and Horizontal Needles equally good, is as their lengths directly. The extremes of the needles have equal velocities; thus a foot needle which vibrates in $5''$, will make four vibrations in the time that a four foot needle vibrates once.

Robert Norman (who was a Compass-maker in Wapping) first discovered the dip of the Needle, and observed it A. D. 1576, to be $71^{\circ}.50'$, and the Variation $11^{\circ}.15'$ E. which are the oldest and the best Observations extant in the world, and which are a standard for all future ages and Observations.

A. D. 1608, Mr. Hudson, a Sailor of fame, and discoverer of unknown countries, from whom Hudson's Bay takes its name, sailed towards the N. Pole, beyond the N. Cape. He made Observations with the Dipping Needle from the Lat. $61^{\circ}.11'$ N. to $75^{\circ}.22'$, and found the Dip 79° to 89° ; off the North Cape and Nova Zembla, the Dip was 84° .

The Rev. Mr. Pound in company with Mr. Cunningham made a voyage to China, and made frequent Observations by the Dipping Needle, but nothing material can be gathered from them.

* Dr. Wallis died 1703.

† To make a needle swim in water. See Seller's Navigation, p. 275, 6.

‡ See Seller's Navigation (2d Edition, 1672), p. 133, &c.

§ Chinese method of using the Compass. N. for North: S. South: E. East: and W. West.

|| The Needles variation first discovered.

¶ The Dip first discovered.

(*) The Variation of its direction from that of the Meridian. Inclination or dip below the Horizon.

(†) The variation of the variation discovered.

(‡) Seller, p. 277, says, that bars of Iron which have been long in position parallel to the Earth's axis, or perpendicular to the horizon, the upper end becomes the North Pole, and the lower end the South Pole.

(§) The vibration of Magnetic Needles, p. 38, Whiston's Book of Magnetism.

Mr. Burrows's OBSERVATIONS of the VARIATION, made at Limehouse
the 16th of October, 1580.

Morning.		Evening.	Variations.
Sun's alt.	mag. az.	az.	
d. m.	d. m.	d. m.	d. m. f.
17.00	52.35	30.00	11.17.30 Var.
18.	50.08	27.45	11.11.30
19.	47.30	24.30	11.30.00
20.	45.00	22.15	11.22.30
21.	42.15	19.30	11.22.30
22.	38.00	15.30	11.15.00
23.	34.40	12.00	11.20.00
24.	29.35	7.00	11.17.30
25.	22.36	0.08	11.14.00

Mean Variation.

d. m. f.
N. 11.17.30 E.

Mr. Gunter's OBSERVATIONS at Limehouse, June 13, 1622.

Sun's alt.	mag. az.	tr. az.	Variation.
d. m.	d. m.	d. m.	d. m.
10.10	71.02	64.49	6.13 E.
19.00	82.02	75.52	6.10 E.
The mean of 8 observations			6.15 E.

42 years variation, decr. $5^{\circ} = 300'$,
which is $7'$ per year.

Mr. Gillibrand's Observ. made at } The mean of 4 in the morning was $4^{\circ} 5' E.$

Deptford, June 12, 1634. } The mean of 6 in the evening - $4^{\circ} 6' E.$

At Paul's Cray in Kent, } The mean of 13 Observations $4^{\circ} 0' E.$ which gives $8' +$ per
July 4, 1634, } year decrease since 1580, or $12'$ per year since 1622.

John Seller's Obs. made at the } Mean of 8 made in } $0.34' W.$ } 32 years gives $8\frac{1}{4}'$,
Hermitage in the year 1666. } June 1666. - } } 36 years gives 6° .

Mr. Millet at Battersea, May 28, 1670, mean of 7 Obs. $2.06 W.$ } or $10'$ per year.

A THEORY of the VARIATION of the MAGNETICAL COMPASS.

(By Dr. HALLEY.)

THE Variation of the Compass, or Magnetical Needle, from the true Meridian, is of that great concernment in the art of navigation, that the neglect thereof does little less than render useless one of the noblest inventions mankind ever yet attained to. And for this cause all ships of consequence, especially those bound beyond the Equator, take with them Azimuth Compasses on purpose to observe this Variation; so that, the course steered by the Compass, may be reduced to the true course with respect to the Meridian.

A TABLE of VARIATIONS. Miscellania, Vol. I. p. 29.

Place.	Year.	Varia.	Place.	Year.	Varia.
		d. m.			d. m. w
London	1580	11.15 E	Hudson's Straits		29.30
	1622	6.00	In Baffin's Bay, at Sir T. }		
	1634	4.05	Smith's Sound $78^{\circ} N.$ }	1616	57.00 W
	1672	2.30 W	Off the Brazil, lat. $8^{\circ} S.$ in	1670	5.30 E
Copenhagen	1649	1.30 E	Off Cape Trio	1670	12.10
	1672	3.35 W	Off the mouth of R. Plate	do.	20.33
Dantzick	1679	7.00	E. entrance of Magel. Straits		17.00
Brest	1680	1.45	West do.		14.10
Rome	1681	5.00	Baldivia, lat. $40^{\circ} S.$		8.10
Hudson's Bay	1668	19.15	St. Helena, $16 S.$	1677	0.40

At

Place.	Year.	Varia. d. m.	Place.	Year.	Var. d. m.	per year. m.
At the mouth of the Red Sea, 13° N. - - -	1674—	15.00W	Paris, in - - -	1666—	0.34W	
At Bombay, 19° N. - -	1676—	12.00		1683—	3.50	$13\frac{1}{2}$
C. Comorin, 8° N. - -	1680—	8.48		1685—	4.10	10
Ballafore, $21\frac{1}{2}^{\circ}$ N. - -	1680—	8.20		1700—	8.12	16
W. Point of Java, $6^{\circ}.40'$ S.	1676—	3.10		1704—	9.20	16
Isle of St. Paul, 38° S. -	1677—	23.30		1720—	13.00	$13\frac{3}{4}$
Van Dimen's Land, 42° S.	1642—	0.00		1740—	16.10	$9\frac{1}{2}$
New Zealand, 41° S. -	1642—	9.00 E		1760—	19.30	$10\frac{1}{2}$
Isle of Rotterdam, 20° S.	1642—	6.20		1770—	20.20	11
Coast of New Guinea, $4\frac{1}{2}^{\circ}$ S.	1643—	8.45	At the Prince of Wales's Fort, Churchill River, Hudson's Bay, Lat. $58^{\circ}.36'$ N. Var. in	1725—	21^{\circ} W	
W. Point of do. $0.\frac{1}{2}^{\circ}$ S. - do.	—	5.30		1746—	17	$11\frac{1}{2}$
				1769—	12 $\frac{1}{2}$	$11\frac{3}{4}$
Place.	Year.	Var. d. m.	per year. m.	English Channel, in	1766—	22.20
London, in -	1662—	0.00 W			1774—	23.30
	1700—	9.40	14	Between the Isle of Sal and the Isle of May, in - }	1770—	12.15W
	1720—	13.00	12	Isle of St. Jago - - - -		8.45
	1740—	16.10	10	Lat. $12\frac{1}{2}^{\circ}$ S. Lon. 31° W. Var. -		0.00
	1760—	19.30	9	Straits of Magellan in -	1766—	22.30 E
	1764—	20.10	10	Coast of Chili in the S. Seas	1767—	16.30
	1774—	22.20	11	Off I. Juan Fernandes - - -		11.00
The mean Increase since 1662—			$11\frac{1}{4}$			

Capt. Cook's Voyage.] In crossing the Pacific Ocean the Variation decreased till we got to Lat. 28° S. and Lon. 12° W. and then it was $1^{\circ}.50'$ E. it then increased as we increased in Lon. to the East Indies.

Colonel Windham observed the Dip at London in 1721 to be $73^{\circ}.45'$; therefore in 145 years the Dip increased $1^{\circ}.55'$; since which time to the year 1774, the Dip has increased very little, to wit $45'$ in 50 years.

Remark, That the adjustment of a Dipping Needle is of a nice and intricate nature so that it is very difficult to make two that shall shew the same quantity of dip.

In the year 1768 I had two Dipping Needles made; the length of one of them $4\frac{8}{10}$ inches, and the other $4\frac{6}{10}$, the axis of each was an inch, which were made to traverse in rubie cylindrical holes, fixed in brass bars and placed across the graduated circular arch; this arch was divided in degrees and half degrees; each Needle had a fine line cut in its middle from one end to the other; by which the position of the needle could be reckoned to every 10 minutes, when it stood either horizontally or vertically. By these I made Observations of the Dip in different parts of this kingdom in the year 1769. The method of using them is: First, to turn the frame of the Needle horizontally to the direction of its Meridian; then to turn it so that the Needle may traverse vertically and in direction of the Magnetic Meridian; and when the Needle stood, I counted the Dip, and then turned the frame on its horizontal axis into an inverted position, and counted the Dip; I then turn the frame half-way round on its vertical Axis, and observed the Dip; also turned it upon its horizontal axis, and noted the Dip. The mean of these four were taken for the true Dip.

1769, The Dip of the N. end of the Needle,

At London -	$74^{\circ}.30'$	At Kendal - - - -	$76^{\circ}.20'$
Lincoln -	75.20	the City of Bath - -	73.30
York - -	75.40	Bristol - -	73.25
Richmond	75.50	Gloucester -	73.30

The Dip of the S. Point of the Needle at St. Helena in 1761, was $7^{\circ}.45'$, and Var. $11^{\circ}.45'$ W. Off

	Lat.	Lon.	Var.
Off C. la Guillis	35° S.	150 ¹ / ₂ E	20° 50' W
Off St. Helena	16 S.	6 W	13. 50
Java -	6.40' S.	105 E	1. 30
	35.00 S.	30 ¹ / ₂ E	20. 00
In Table Bay	33.50 S.	18 E	19. 40
Off Pico & Fyal	28.00 N.	16 W	16. 00

Dr. Bradley's Observations made at the Royal Observatory at Greenwich.

1749, Jan. 7th	-	17°.22' ¹ / ₂ W	73°.30'
1750, June 24	-	17.25	73.30
1752, Aug. 28	-	17.55	73.25
1756, Nov. 16	-	18.33	73.25
1757, Aug. 5	-	18.32	73.20

A dipping needle is a Magnetic needle with an axis through its middle. When in use it is made to vibrate upon its axis, supported horizontally, its vibrations are made in a plane perpendicular to the horizon; and when this vertical is in direction of the Magnetic Meridian: That end of the Needle which rests below the horizontal position is the Dip below the horizon.

Lat. 52° S. Lon. 63° W. Dip 63°.00' S.end.

Of the DIURNAL VARIATION of the MAGNETICAL NEEDLE, as determined by Mr. J. CANTON, M. A. and F. R. S.

The mean diurnal Variation for each month as deduced from the Observations made in the Year 1759.

Jan.	7'. 8"
Feb.	8.58
March	11.17
April	12.26
May	13.00
June	13.21
July	13.14
Aug.	12.19
Sept.	11.43
Oct.	10.36
Nov.	8.09
Dec.	6.58

By Observation it is evident, that the Magnetic parts of the earth in the North, on the East side, and the Magnetic Parts of the Earth on the West side, of the Magnetic Meridian, equally attract the North end of the Needle. If the Eastern Magnetic parts are heated faster by the Sun in the morning, than the Western, the Needle will move Westward, and the West Variation will be increased by the moving of the Needle Westward. When the attracting parts of the earth on each side the Magnetic Meridian have their heat increased equally, the Needle will be stationary; and the absolute Variation will then be the most increased: When the Western Magnetic parts are either heating faster, or cooling slower than the Eastern parts, the North end of the Needle will move Eastward, and the West Variation will be decreased, till the parts be equally heated, and then it will become stationary, and the Western Variation will then be the most decreased, but the

Eastern Variation will be the most increased.

Remark I. This may be illustrated by placing the Compass and two Magnets, one on each side of the Compass, and parallel to the Magnetic Meridian, so that the South ends of both the Magnets act equally on the North end of the Needle, and keep in the Magnetic Meridian; but if either of the Magnets be taken away, the other shall attract the Needle so as to stand at 45° on each side. If the Magnets be in cases or the like, and boiling water be poured on one of them, as the Magnet heats the Needle will move from it; so it appears the Magnetic power decreases by heat. 2. If a screen be placed, and so moved that the sun may shine only on one of the Magnets, the Needle will decline from the heated Magnet. So far by Mr. J. Canton.

3. There is a certain degree of Heat or cold, wherein the Magnetic power is the greatest, which I suppose to be a temperate state, of which I propose to give some account hereafter.

Straits la Maire Lat. 54°.40' S. Dip 68.51
On board ship, at Anchor, in }
the above Bay, Lon. 69° W. } 65.00
Lat. 18¹/₂° S. 141° W. - - - 30.00

Each of the above is the mean of 10 or 12, or more, with the face of the instrument turned alternately East and West, by means of a swinging table; the Compass did pretty well at sea, to a degree or two; the Dip may be depended upon.

May 30, At George's Island, Dip } 29°.26'
South point - - - - - }

The face turned to opposite side - 29.40
Mean 29.33

Another 30°.10'

31.45

61.55

30.57¹/₂ the mean of 24 was 30°.43'

Lat. 34° S. Lon. 208¹/₂ W. dip 67°.01' } S.end
15¹/₂ S. — 215 W. — 36.00 }

At K. George's Island (or Otaheite) spring tides 13 inches.

H. W. at 11 h. 15 m. } neap tides 7
full and change }

OF GEOGRAPHY.

GEOGRAPHY is the science of describing the earth, that is, of describing the magnitude, figure and position of the several parts of its surface.

The figure of the earth is found by observations, to be nearly spherical; and by the measures that have been made by the French, at the arctic polar circle; by the Spaniards and Portuguese, at the Andies and parts adjacent; and by Mr. Norwood, from London to York (in the year 1635); and by Messrs. Mason and Dixon, in the province of Maryland, in America, in the year 1768, by order of the Royal Society, by which it appears that one degree of the meridian contains 69 English miles *, in the lat. from 43 to 44°, which agrees with the Newtonian table. See Mott's Newton, B. iii. p. 247.

But before we proceed any further, it will be necessary to lay down the principles of the art, by definitions.

1. In order to describe the Positions of places, geographers have found it necessary to imagine certain circles, semicircles and circular arches, drawn on the surface of the earth, to which they have given the names of equator, meridian, horizon, solstitial and equinoctial colures, tropics, parallels of latitude, polar circles, parallel circles, azimuth or vertical circles, &c.

2. The equator is a great circle of the earth, equally distant from its poles (def. 5.); and it is that circle in whose plane the earth performs its diurnal motion round its axis, or it is that circle, parallel to which, the whole heavens seem to turn round the earth from East to West in 24 hours.

3. The plane of the equator divides the globe of the earth, and also the whole heavens into two equal parts, which are called the Northern and Southern hemispheres. Under the equinoctial, the days and nights are always of an equal length; but in places which have latitude they continually vary.

4. The zenith of a place is the point in the heavens perpendicular to the horizon of that place, or right over our heads. The nadir is diametrically opposite to the zenith; and therefore right under our feet.

5. The axis of the equator is called the axis of the earth; and its continuation, the axis of the world; about which the earth and all the stars in the heavens appear to revolve in 24 hours: The extremes of the earth's axis are called the poles of the earth; and that pole in the Northern hemisphere, is called the North pole; and that in the Southern, the South pole.

6. The astronomers divide all circles into 360 equal parts, called degrees; each degree into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds; and so on.

N. B. 56992 toises is = 69 English miles = 121440 yards.

But, besides this division, the equinoctial (whose plane coincides with the plane of the equator continued to the heavens) is also divided into 24 equal parts, called hours; each hour into 60 equal parts, called minutes; and each minute into 60 equal parts, called seconds: So that 1 hour is = 15° of the equinoctial; and each minute of time is = 15' of motion of the equator, upon its axis.

7. All circles, or more properly, all circular arches †, conceived to pass from pole to pole, intersecting the plane of the equator at right angles, are called hour circles, or meridians: And that which passes through the zenith of a place, is the meridian of that place.

8. A meridian is a semicircle of the sphere passing from pole to pole through the zenith, and intersects the equator at right angles, as represented on the surface of the terrestrial globe.

9. The

(*) Remark, that a degree of the meridian (or 1 deg. of latitude) at the equator is the least, and only contains 120684 yards.

But 69 English miles, or $1760 \times 69 = 121440$ divided by 60 is 2024 yards in 1 minute of latitude.

diff. 756 yards; therefore 1 deg. at the equator is little more than 68½ miles English: But in lat. 44 deg. it contains 69 miles.

(†) Arc, or arch; arcs, or arches.

9. The horizon is of three kinds: 1, The sensible, or visible: 2, The rational: 3, The true horizon.

The visible horizon divides the upper or visible hemisphere from the lower or invisible one; therefore the visible or apparent horizon is that apparent line which limits our view at land or sea, where the land and sky appear to meet.

The semidiameter of this circle or curve line varies at sea according to the height of the observer's eye.

The rational horizon is that great circle which may be supposed to pass through the centre of the earth, parallel to the true tangential horizon.

The true horizon of any place is a plane, the positions of its several parts being a tangent to the curve of the earth's surface at that place, which is 90° from the zenith in every position and place.

10. Latitude is the distance of a place from the equator, in degrees, minutes, &c. and it is measured in the meridian of a place, by a quadrant, or the like instrument.

11. Longitude of a place is the inclination of the meridian of that place with the meridian of any other place: And the difference of longitude of two places is the distance of the meridians of those places reckoned at the equator, which is equal to the angle made by them at the pole: Or the longitude of a place is the distance between the first meridian and the meridian of that place at the equator.

12. Parallels of latitude are imaginary circles (that may be conceived on the surface of the earth) parallel to the equator. Every place has its parallel of latitude: A place in any degree of North latitude has its parallel in the same degree of South latitude:

And two places having the same latitude North or South, are said to be in the same parallel of latitude; but one in the North, and the other in the South latitude, are in opposite parallels of latitude.

13. Difference of latitude is an arc (or arch) of a meridian, contained between the parallels of latitude of the places.

14. Difference of longitude is an arc of the equator, contained between the meridian, where longitude begins, and the meridian of any other place. [Def. 11.]

Remark, 1st. Latitude begins at the equator: But the longitude of places, by different countries, is generally reckoned from the meridians of their capital cities. As the French reckon longitude from the meridian of Paris: The English, from the meridian of London, or Greenwich: Also longitude is reckoned both East and West from the first meridian, to its opposite meridian, 180° , or 12 hours, difference of time.

Remark, 2^d. When the latitude of two places are both North, or both South; or their longitudes both East, or both West, they are said to be of the same name: But when one latitude is North and the other South, or one longitude East and the other West, they are said to be of contrary names.

Remark, 3^d. The eye of a spectator is always supposed to be in the centre of the horizon.

15. The elevated pole of a place, is the pole of the same name, as the latitude of the place; and it is the pole which is above the horizon of the place, and therefore elevated; the other pole being the same quantity depressed below the opposite point of the horizon, is called the depressed pole.

The DIVISION of the EARTH into ZONES.

16. **A** ZONE is a broad space of the Earth, contained between two parallels of latitude. There are 5 zones; one torrid, two frigid, and two temperate: these names arise from the quality of heat and cold that their situations are liable to.

1st. The torrid zone is that part of the surface of the earth, to which the sun is perpendicular, or passes their zenith some time of the year: This zone contains the same number of degrees as the sun makes in declination North and South, to wit. $23^\circ.28'$ on each side the equator.

The Northern limit is called the tropic of Cancer.

The Southern limit is called the tropic of Capricorn.

2^d. The frigid zones are those about the poles, and are bounded by circles $23^\circ.28'$ from the poles.

3^d. The

- 3d. The temperate zones are the spaces contained between the torrid and frigid zones.
 17. A climate is that part on the surface of the earth contained between two parallels of latitude, where the difference between the longest and the shortest day is half an hour, reckoned from the equator to the polar circles: From the polar circles to the poles, the climates are measured by the increase of a month.

Of the NATURAL DIVISIONS of the EARTH.

BY the natural divisions is meant the parts on its surface formed by nature, such as Continents, islands, mountains, oceans, seas, rivers, &c.

The surface of the earth is naturally divided into land and water.

L A N D is divided into

- 1st, Continents, or large tracts of land.
- 2d, Islands, or small tracts of land, surrounded by water.
- 3d, Peninsulas are joined to other lands by a neck of land.
- 4th, Isthmus, the neck that joins the main land to the peninsula.
- 5th, Promontaries are mountains which stretch into the sea.
- 6th, Mountains are parts of land more elevated than the adjacent lands.

W A T E R is divided into

- 1st, Oceans, or large collections of Water.
- 2d, Seas, or branches of oceans.
- 3d, Gulfs, or parts of seas contained by two shores.
- 4th, Straits, or narrow passages where waters flow.
- 5th, Lakes are large collections of water in an inland country.
- 6th, Rivers are streams of water flowing from mountains and high lands.

N A M E S of O C E A N S.

1, The Atlantic: 2, The Pacific: 3, The Indian: 4, The Southern: And 5, The Northern; which reaches to the Northward of Europe and of America towards the North pole.

Of the POLITICAL DIVISION of the EARTH.

BY the political division, is meant the different countries, empires, kingdoms, states, and other denominations established by men; either from the ambition of princes, or for the sake of good government.

There are three species or kinds of Government, monarchy, aristocracy and democracy.

The word monarchy is compounded of two Greek words, viz. *monos* single or alone, and *archia* empire, or the chief power in any country.

The word aristocracy is derived from two Greek words, viz. *aristos* the best, and *cratia* power, nobility: Thus Venice is a proper aristocracy, where the whole power is lodged in the nobles.

Democracy is compounded of two Greek words, viz. *demos* the people and *cratia* power, &c.

All republics ought to consist of an equal mixture of aristocracy and democracy; but for want of a third power to keep the balance even, the two branches were almost always at variance; which contributed chiefly to the total ruin of all the antient republics.

There is a fourth species of government, mentioned by the ancient political writers, termed an ochlocracy, or mob-government, where the refuse of the people, or the mob usurped the chief power in the state: This species of government was the worst of all, as it generally ended in anarchy*, which always introduced tyranny; and this was the fate of most of the ancient republics.

There are three kinds of monarchical governments.

1. The despotic; where the prince alone is free, and the people from the highest to the lowest are absolute slaves. Of this kind are all the Eastern and all the Mahometan governments.

2. Monar-

* The word anarchy is compounded of two Greek words, the preposition *a*, or *an*, not, or without, and *archia* power or government.

2. Monarchical; in which the people are governed by written laws, though the princes are absolute. Of this kind are France, Spain, Portugal, Denmark, Prussia, and at present, Sweden, also the hereditary dominions of the empress queen*, and of all the petty sovereigns of Germany, the kingdom of Sardinia, of the two Sicilies, and of all the petty sovereigns of Italy.

3. Mixed Governments; consisting of an equal mixture of monarchy, aristocracy and democracy. Of this last kind are Great Britain and Poland; though, strictly speaking, Great Britain is the only perfect Government of this kind in the known world. For, as the common people in Poland, who are reckoned to amount to eight or nine millions, have no more share in the government than their cattle, the Polish government may rather be termed an anarchy, as they are always in a state of civil discord and confusion.

The principal republics subsisting at present, are Holland, the Swiss Cantons, Venice, Genoa, Hamburgh, Dantzick and Lubeck; the little state of Geneva, and the petty republics of Lucca and San Marino, are still reckoned in the number of the republics.

THE surface of the earth is divided into four parts, called quarters; which are Europe, Asia, Africa and America.

The Eastern continent comprehends the three first, and the Western continent only America.

The sovereignties of Europe are;

The three empires, of Germany, Russia, Turkey.

The two kingdoms of Great Britain and Ireland, the kingdoms of France, Spain, Portugal, Sweden, Denmark, Poland, Hungary, Bohemia, Prussia, Sardinia, Naples and Sicily, which are termed the Two Sicilies. The Papedom of Rome.

The republics of Venice, United Netherlands, Switzerland, the Grefons, Genoa and Lucca; and the small republics of Geneva and Ragusa. The Electorates of Germany, whose princes chuse the emperor; of Mentz, Triers and Cologne, which are also Archbishopricks: The others are Bavaria, Saxony, Brandenburg, Palatine, Brunswick, Lunenburg, and the kingdom of Bohemia. And there are, besides these, about 300 subaltern sovereignties in Germany and Italy.

The Cham of European Tartary, and the Hasphoders of Walachia, Moldavia, &c.

The continent of Europe was anciently divided into eight parts.

1. Scandinavia, including Sweden, Denmark and Norway; their capital cities are Stockholm, Copenhagen, and Bergen.

2. Muscovia, or Russia,	-	chief city, Moscow.	River, Wolga.
3. France	-	- Paris.	Loire and Rhone;
4. Germany	-	- Vienna.	Danube.
5. Poland	-	- Cracow.	Vistula.
6. Spain	-	- Madrid.	Tagus.
7. Italy	-	- Rome.	Po and Tyber.
8. Turkey in Europe	-	- Constantinople.	Danube.

EUROPEAN ISLANDS.

England, chief city, London. River Thames. Scotland, chief city, Edinburg. R. Forth. Ireland, chief city, Dublin. R. Shannon. Besides these, a great number of small islands, as may be seen in the Map of Europe.

Europe is bounded on the North, by the Frozen Ocean; on the South, by the Mediterranean Sea, which parts it from Africa; on the East, by the Archipelago, the Black Sea, and the Palus Mæotis, and thence by a line from the river Tanois, or Don, almost to the river Oby in Muscovy; on the West, it is bounded by the Atlantic Ocean. Europe is situated between the latitudes of 31° N. and 80° ; and between the longitudes of 11° W. and 60° E. that is, on the East, where it joins Asia. At Sol-Skamskoi, in 59° N. and $58\frac{1}{2}^{\circ}$ E. and from thence to the North, bounded by a chain of high mountains to Weigate's Straits in 59° N. and 57° E. and includes Weigate Isle and Nova Zembla. European Islands, Cherry I. Spitzbergen, Iceland, Shetland, Scilly I. &c. also the Azores which belong to Portugal.

Asia is bounded on the North, by the Frozen Ocean; on the East, by the Pacific Ocean (which in the latitude of 66° N. lon. 155° W. it is only 5° of lon. or 140 miles a-cross from

F

America

* Of Hungary.

America to Asia, as discovered by the Russians in the year 1728 and 1730, by Capt. Bering. See the Chart of Kamschatka). On the South, by the Indian Ocean; and on the West, by the Red Sea, the Mediterranean Sea, Archipelago, the Black Sea, &c. as in the Eastern limit of Europe.

In this quarter are three grand divisions: 1. The Empire of China, Chinesian Tartary and the Oriental Isles. 2. India, Usbec Tartary, Calmuc Tartary and Siberia. 3. Persia, Arabia, Astracan and Circassian Tartary, and Turkey in Asia on the West.

The principal SEAS, GULFS and BAYS in ASIA, are;

The Caspian Sea, which is encompassed by Siberia.

Korean Sea, between Korea and Japan.

Yellow Sea, between China and Japan isles.

Gulph of Cochin-China, on the borders of Tonquin and Cochin-China.

Bay of Siam, between Molacca and the kingdom of Siam.

Bay of Bengall, between the coast of Siam and Coromandel.

Gulph of Persia, between Arabia and Persia.

Africa is bounded on the North, by the Mediterranean Sea; on the East, by the Red Sea; on the South and the West, by the Atlantic Ocean.

The Divisions of Africa are; 1. Egypt. 2. Abyssinia, containing the Upper Ethiopia and Nubia. 3. The Coast of Anion* and Zangubar. 4. Monoemugi, Monomotapa, and Cofraria, or Lower Ethiopia. 5. Congo, Angola and Guinea. 6. Negritia, or Negroland. 7. Zoara, or the Desert. 8. Biledulgerid. 9. The Empire of Morocco. 10. The Coast of Barbary, comprehending the countries of Algiers, Tunis, Tripoli and Borea.

The principal GULFS, SEAS, BAYS, &c. are;

Mosambique sea, between Africa and Madagascar. Suldanna Bay, by the Ethiopic Ocean. Bight of Benin on the Coast of Guinea. Their principal islands are; 1. Madeira. 2. Canary Isles. 3. Cape de Verd Isles. 4. Ethiopian Islands. 5. Komora Isles. 6. Sokotora Isles. 7. Almirantei Isles, in the Indian Ocean. The island of Madagascar is one of the largest, and situated between the Indian Sea and Ocean.

The Isles of Bourbon and Mauritius, East of Madagascar, belong to the French.

The I. of Madeira, and Cape de Verd Isles, to the Portuguese.

The Canary Isles to Spain; St. Helena to England.

The NAMES of the COUNTRIES, Chief CITIES, or TOWNS, and RIVERS in NORTH-AMERICA, are as in the table following.

Countries.	Chief city or town	Rivers.	The Apalachian Mountains
Canada - - -	Quebec	St. Lawrence	extend over Georgia, Carolina, Virginia, Maryland and Pennsylvania.
New Britain, or Labrador, and Eskimaux - -	Port Rupert	Rupert	
New Wales - - -	Port Nelson †	Nelson, Hayes	† Mexico, the capital of the kingdom, the residence of the viceroy of Old Spain; who acts as despotically as any prince in Europe. (See Salmon's Gazetteer.)
Nova Scotia, or New Scotland	Hallifax	St. John	This city is one of the richest and most splendid in the world; tho' it has no navigable river, yet it has a very great commerce: Its ports are La Vera Cruz, on the Coast of the bay of Campeche; and Acapulco, on the opposite coast of the Pacific Ocean.
New Jersey - - -	New York	Albany	Their gold and silver are coined at the city of Mexico, and the king's 5th is deposited there. (See Martin's Geography.)
Pennsylvania - - -	Philadelphia.	Delawar	
Maryland - - -	Annapolis	Powtomack	
Virginia - - -	James-Town	Powtomack	
Carolina - - -	Charles-Town	Ashley	
Georgia - - -	Savannah	Alatamaha	
Florida - - -	St. Augustin	St. John	
Louisiana - - -	Port Louis	Mississipi	
New Albion and California	St. Juan	Ri. of the West	
North, or New Mexico, or Granada - - -	Santa Fee	New River	
Old Mexico, now called	Mexico	Panuco	
New Spain - - -			

Note, Old and New Mexico and California belong to Spain; the rest to Britain.

* Or Ajan, is peopled by the wild Arabs.

† Or York Fort, on Hayes's River: No factory on Nelson River. Prince of Wales's Fort at the mouth of Churchill River. See Robson's account of Hudson's Bay, p. 25.

In

In SOUTHERN AMERICA:

Countries.	Chief City or Town.	Rivers.	Mountains the Andes.
Terra Firma, or New Granada	Carthagena	Magdalen, Zule & Oronoco	
Amazones and Guayana	Surinam	Amazones and Esquebe	
Brazil	St. Augustin and St. Salvador	St. Francisco and Rio Real	
Peru	Lima	Coquimayo	
Paraguay	Assumption	Paragua	
Chili	St. Jago	Valparisa	
Patagonia		Defaguadero	
La Plata	Buenos Ayres	La Plata, compos'd of Paragua & St. Fee.	

The Spaniards possess Terra Firma, Peru, Chili, La Plata, and the Islands of Cuba, part of Hispaniola, Porto Rico, Trinidad, Margareta, with several other small islands. The Portuguese settlements are the Brazil and the Amazones. The French settlements in South America, are part of Hispaniola, Desiada, St. Bartholomew, Marigalante, Santa Lucia and Caen. In North America, Martinico, Guadaloupe, New Orleans, and the island of Louisiana, at the mouth of the river Mississippi, provided that the navigation of that river be equally free to the subjects of Great Britain as to those of France. The Dutch possess the Isle of Curasou and Eustatia, and some part of Guayana. The Danes, the isle of Santa Cruz, which is a large sea-port in the Isle of Cuba.

AMERICAN ISLANDS in the ATLANTIC OCEAN.

Newfoundland, Cape Breton, Sable I. Bermudas, or Summer Islands.

Bahama Isles ; Great Antilles, }	Cuba,	chief town, Havanna.
	Hispaniola,	San Domingo.
	Jamaica,	Kingston.

Caribbee Isles, called the Windward Islands.

Lesser Antilles, or Leeward Islands, near the coast of Terra Firma.

Terra del Fuego, South of Patagonia ; its Southermost point makes Cape Horn.

Gallipago Isles, off Peru, in the Pacific Ocean.

Solomon's Islands in South lat. in the Pacific Ocean ; with a great many others.

America, the greatest part of the four quarters, was first discovered by Christopher Columbus in 1491, who had the commission of Admiral to their Catholic Majesties, and was made viceroy of all the islands and continents he should discover and acquire.

In his first voyage he discovered the Bahamas isles, Cuba and Hispaniola. In his second voyage in 1494, he discovered Dominique, Marigalante and Guadaloupe. In his third voyage in 1498, he discovered the vast inland continent of America, or Canada. In his fourth voyage in 1502, he discovered the isle of Jamaica, the Bay of Honduras, and many adjacent countries.

Sometime after Vespacius Americus had a commission from the king of Portugal, and made two voyages to the New World, as it was then called : He claimed the discovery of that part which lies under the line, and he gave it the name of America.

America is bounded on the East, by the Atlantic Ocean ; on the West and South, by the Pacific Ocean ; and on the North, by the Frozen Ocean.

This large continent is divided into North and South America by the gulph of Mexico, and the Darien joins them by its Isthmus*.

North America lies between the latitude of 7° and 80° N. and between the longitude 50° and 130° W. from the meridian of London.

South America lies between 12° N.* and 58° S. latitude, and between 36° and 85° W. longitude.

* See the Map of America, and view the Isthmus of Darien.

P R O B L E M I.

The latitude of one place and the difference of latitude between it and any other place being given, to find the latitude of that other place.

Case 1st, When the given latitude and difference of latitude have different names, subtract the lesser (number of degrees and minutes) from the greater, the remainder will be the latitude of the same name with the greater.

Case 2d, When the given latitude and the difference of latitude have the same name, add the difference of latitude to the given latitude, and the sum will be the other latitude.

P R O B L E M II.

To find the difference of latitude and longitude of any two places.

Case 1, When the latitudes and longitudes are of the same name.

Rule, From the greater latitude take the lesser, and from the greater longitude take the lesser longitude, and you will have the differences required.

Case 2, when the latitudes and longitudes are of different names.

Rule, The sum of the latitudes, and the sum of the longitudes are the differences required: That is, the sum of the latitudes is the difference of latitude; and the sum of the longitudes is the difference of longitude.

Example 1. What is the difference of latitude and the difference of longitude between London and the Burlings.

London - - lat. $51^{\circ}.30'$ — lon. $0^{\circ}.00'$
 Burlings - - 39.35 — 9.24^W
 Difference of lat. 11.55 of lon. 9.24

Ex. 2. The Lizard lat. $49^{\circ}.57'N$ lon. $5^{\circ}.15'W$
 Ferro Island 27.54^N 17.45^W
 Difference of lat. 22.03 of lon. 12.30

Ex. 3. A ship sailed from the lat. of $54^{\circ}.15'S$ to the lat. $30^{\circ}.20'S$ and from the lon. of $5^{\circ}.20'W$ to $37^{\circ}.11'W$. What difference of lat. and lon. has the ship made:

Lat. from $54^{\circ}.15'S$ — lon. $5^{\circ}.20'W$
 Lat. in - 30.20^S — 37.11^W
 Diff. of lat. 23.55 of lon. 31.51

Ex. 4 A ship from the lat. $35^{\circ}.40'N$ and lon. $15^{\circ}W$. sailed to the lat. of $15^{\circ}.10'S$ and lon. $37^{\circ}.20'E$. What difference of lat. and lon. has the ship made.

Lat. from $35^{\circ}.40'N$ — lon. $15^{\circ}.00'W$
 Lat. in - 15.10^S — 37.20^E
 Diff. of lat. $50.50'$ of lon. 52.20

P R O B L E M III.

The latitude and longitude of a place being given, and its difference of latitude and of longitude from any other place, to find the latitude and longitude of that other place.

Case 1st, When the latitude and difference of latitude have the same name; and the longitude and difference of longitude the same name.

Rule, To the given latitude and longitude add the difference of latitude and of longitude, the sum will be the latitude and longitude required.

Ex. 1st, A ship from the latitude $50^{\circ}S$. longitude $6^{\circ}W$. sailed till she had differed her latitude $5^{\circ}.40'S$. and her longitude $7^{\circ}.15'W$. What latitude and longitude is she in?

Lat. from - - $50^{\circ}.00'S$ — lon. $6^{\circ}.00'W$.
 Diff. of lat. made 5.40^S — 7.15^W .
 Lat. in - - - $55^{\circ}.40'S$ — lon. in $13^{\circ}.15'W$

Case 2d, When the difference of latitude and of longitude have contrary names to that of the given place.

Rule. From the greater latitude take the lesser latitude, and from the greater longitude take the lesser longitude, and you will have the latitude and the longitude required.

Ex. 1. A ship from the lat. $36^{\circ}.30'N$. and $5^{\circ}.40'E$. sailed till she had differed her latitude $3^{\circ}.37'S$. and longitude $15^{\circ}.10'W$. What latitude and longitude is the ship in?

Lat. sailed from $36^{\circ}.30'N$ — lon. $5^{\circ}.40'E$
 Diff. of lat. made 3.37^S of lon. 15.10^W
 Lat. of the ship 32.53^N — lon. 9.30^W

Ex. 2. lat. from $5^{\circ}.40'N$ — lon. $1^{\circ}.20'E$
 Diff. of lat. 20.10^S — 4.40^W
 Lat. in - 14.30^S — lon. 3.20^W
 SOUTH

SOUTH COAST of England, bounding the British Channel, and the opposite Coast of France. Latitude, Longitude from London, and the Time of High Water; and, in the Offing of some Places, the Time that the Current runs.

English Coast.	H. W.	Lat.	Lon.	French Coast.	H. W.	Lat.	Lon.
	h. m.	d. m.	d. m.		h. m.	d. m.	d. m.
North Foreland -	10.30	51.25 ^N	1.34 E	Dunkirk -	12.00	51.02 ^N	2.27 E
Ramsgate -	10.30	51.20	1.30	Graveline -	11.45	51.00	2.12
Deal -	10.30	51.14	1.30	Calais -	11.30	50.57	1.56
The Downs -	10.30	51.25	1.40	Boulogne -	10.30	50.43	1.42
South Foreland -	10.30	51.12	1.32	Abbeville -	10.30	50.07	1.56
Dover -	10.30	51.07	1.22	Dieppe -	10.30	49.57	1.09
Dengenefs -	9.45	51.00	1.06	Havre de Grace -	9.00	49.30	0.17W
Rye -	11.15	51.03	0.50	Rouen up R. Syne -	1.15	49.27	1.10
Haftens -	11.00	50.52	0.50	Syne R. Mouth -	9.00	49.36	0.30
Beachyhead -	11.00	50.48	0.24	Caen -	9.00	49.11	0.16
Brighthelmstone -	10.00	50.50	0.00	C. Barfleur -	7.30	49.38	1.16
Arundel -	9.00	50.50	0.24 ^W	Cherburg -	9.00	49.38	1.34
Chichester -	11.00	49.52	0.43	C. de la Hague -	12.00	49.42	1.45
Shoreham -	9.45	50.51	0.08	Coutances -	6.00	49.02	1.27
Portsmouth -	11.15	50.48 ¹	1.00	Granville -	6.00	48.50	1.36
Southampton -	12.00	50.55	1.22	Auranches -	6.00	48.41	1.24
Spithead Road -	11.15	50.48	1.06	St. Malo -	6.00	48.39	1.57
Cows, I. of Wight -	11.30	50.48	1.16	Seven Islands -		48.53	3.30
St. Helen's Road	10.30	50.43	0.55	Isle de Bas -	3.45	48.50	4.00
Bembridgeledge, I. Wi.	10.20	50.40	0.52	Coast of the bay of Biscay			
Dunnose -	9.45	50.35	1.07	Brest -	3.45	48.23	4.26W
St. Catherine's Point.	9.00	50.34	1.14	Port Louis -	3.00	47.48	3.20
Needles 10 h. 15 m.	8.15	50.42	1.34	Remark. That the Tides meet in the Chan- nel between Dungenefs and Haftings, and the opposite Coast of France, near Staples:			
Christ Church -	8.15	50.46	1.44	And the Current in mid Channel runs N. E. about 1 h. 30 m. after High Water. And it runs off Dungenefs, 4 h. to 4½. In the Downs 4 h. East of the King's Channel, 3 h. after h. w.			
Pool, Dorsetshire -	6.45	50.46	1.54	Since it makes H. Water on the Full and Change Days; Off the Lizard, at 4 h. 30 m. And off Dover, at 10 30 Hence it makes 6° of lon. to the east in } 6 00, or 1 d. per hour.			
Peveral Point -	8.40	50.36	1.42	And by making this allowance proportionally we shall have			
St. Alban's-head -	8.30	50.28	1.50	Current runs after h. w.			
Weymouth -	7.30	50.38	2.17	High Water	h. m.	h. m.	h. m.
Bill of Portland -	6.30	50.31	2.16	At the Lizard, at	4 30	3 00	7 30
Exmouth Bar -	5.45	50.32	3.10	Off the Eddystone,	5 30	3 00	8 30
Exeter -	0.00	50.40	3.14	Off the Start,	6 00	2 30	8 30
Torbay -	5.15	50.34	3.18	Off Portland	7 15	3 00	10 15
Dartmouth -	5.15	50.27	3.26	Off the I. of Wight,	8 15	3 15	11 30
Start Point -	6.45	50.09	3.28	Off Arundell and } Shoreham,	9 15	1 15	10 30
Prall, S. P. of Devon.	0.00	50.05	3.33	Off Beachy,	9 45	1 15	11 00
Plymouth -	6.00	50.21	3.52	Off Dungenefs	10 30	4 00	2 30
Eddystone Tide runs	8.15	50.07	4.00	And make the time the Cur- rent has done running			
Ram Head -	7.30	50.16	3.56				
Falmouth -	7.30	50.10	5.00				
Lizard Point -	7.30	49.57	5.15				
Mount's Bay -	4.30	50.05	5.38				
Land's End -	7.30	50.06	5.52				
Scilly -	3.45	50.00	6.42				
St. Marie's -	3.45	49.58	6.40				
Alderney and Caskets	12.00	49.48	2.10				
Guernsey I. and Sark I.	1.30	49.30	2.47				
Jersey I. -	1.30	49.07	2.26				

G

EAST

Remark. H. W. for High Water, Lat. Latitude, Lon. Longitude, h. m. hours, minutes, d. m. degrees, minutes.

EAST COAST of England, and at Places up Rivers which run into the German Ocean.

N A M E S.	H. W.		Lat.	Lon.	Isles of Orkney.	H. W.		Lat.	Lon.
	h. m.	d. m.	d. m.	d. m.		h. m.	d. m.	d. m.	d. m.
R. Thames, London	3.00	51.30	n	0.00 E	Pickland Skeries -	3.00	58.54	n	3.00 W
Gravelend	1.30	51.28		0.20	Pomona the chief Isle	3.00	59.24		3.20
R. Medway, Rochefter and Chatham }	0.45	51.25		0.36	North Ronalfa, the	3.00	59.46		2.45
Sheerness - -	12.00	51.31		0.50	Northermost of them }				
The Nore - -	12.00	51.34		1.06	—Shetland Isles.				
Margate - -	11.00	51.25		1.20	Fair Isle.	3.00	59.30		2.20 W
King's Channel - }	10.30	51.38		1.16	Foule Isle - -	3.00	60.12		2.40
along the Swinruns }	12.00				Sella Isle - -	3.00	60.35		2.24
Kentish Knock, the					Balta Isle - -	3.00	60.31		1.04
Eastermost Sand in					Sears Isle - -	3.00	60.15		1.00
the King's Channel	10.30	51.37		1.40	W. coast of Scotland.				
Nor. of the Downs					Farro-head, or C. Wrath	0.30	58.40		4.50
the Current runs till	1.00				Isle of Lewis - -		58.30		6.30
Harwich 10 h. 30 m.	11.15	51.58		1.20	I. of Sky, Northend.		57.45		6.35
Ipswich 11 - -	11.00	52.08		1.10	Douglafs I. of Man.	10.30	54.10		4.24
Sole Bay - -	9.30	52.24		1.50	West coast of England.				
Leftoff 10 - -	9.00	52.36		1.52	White Haven - -	10.45	54.35		3.15 W
Tower Lights - }	8.00	52.48		1.44	St. Bee's-head - -	10.45	54.30		3.25
Wintertonnes Lights }		52.50			Lancaster - -	11.00	53.42		4.06
Orforenes - -	9.45	52.10		1.20	Chester or W. Chester }	11.30	53.12		3.00
Yarmouth - -	9.30	52.45		1.50	R. Dee - -				
Do. Road - -	8.15				Parkgate - -	11.00	53.17		3.15
Cromer (Lights) -	7.30	53.03		1.14	Liverpool, R. Mersey	11.00	53.22		2.30
Wells - -	6.45	53.04		1.00	Holyhead - -	11.30	53.23		4.40
Lynn, in Norfolk -	6.00	52.50		0.22	Barley or Bardfly I.	3.30	52.44		5.00
Boston - -	6.00	53.10		0.12	St. David's-head -	6.00	51.55		5.02
Mo. of R. Humber }	5.15	53.30		0.16	St. Bride's Bay -	5.00	51.56		4.50
the Spurn - }					Gresholm Isle - -	5.30	51.50		5.12
R. Humber, Hull -	6.00	53.45		0.12 W	Milford Haven -	5.15	51.45		4.45
Bridlington Bay -	3.45	54.06			Swansea - -	6.00	51.40		3.50
Flamborough Head	3.00	54.10		0.56 E	Mouth of the Severn, }	6.00	51.22		3.10
Scarborough - -	3.45	54.18		0.12 W	Flatholme's Isle }				
Robin-hood Bay -	3.45	54.22		0.17	Bristol - -	6.45	51.26		2.45
Whitby - -	3.00	54.30		0.22	Lundy Island - -	5.15	51.20		4.25
R. Lee's Mouth -	3.00	54.40		1.00	Hartland Point -	4.30	51.08		4.30
Stockton - -	5.15	54.37		1.10	C. Cornwall 5 h. 30 m.	7.00	50.10		5.50
Hartlepool - -	3.00	54.45		1.00	Land's End 5 30	7.30	50.06		5.52
Sunderland - -	3.00	54.56		1.10	—Coast of Ireland.				
North Shields - -	3.00	55.02		1.12	Dublin - -	10.30	53.12		6.55 W
Newcastle - -	5.15	55.02		1.26	Wexford - -	9.45	51.13		7.16
Tinmouth Castle -	3.00	55.04		1.12	Waterford - -	7.30	52.07		7.52
Sunderland Point -	3.00	55.32		1.24	Cork, the Cove -	5.15	51.40		7.30
Holy Island - -	2.45	55.40		1.34	Kinsale - -	6.00	51.32		9.20
Berwick - -	2.30	55.46		1.42	Cape Clear - -	5.45	51.18		9.50
St. Abb's Head -	2.00	55.54		1.50	Limerick - -	6.00	52.22		9.48
Dunbar - -	2.00	56.00		2.18	Galway - -	6.30	53.10		10.03
Edinburg - -	4.30	55.58		3.00	Slieve Head - -		53.20		11.15
Buckanefs - -	3.00	57.30		1.35	Londonderry - -	7.30	55.01		7.31
Cathnecs Point, or }	9.00	58.46		3.17	Fair Foreland - -		55.10		6.25
Dinner's Head }					Belfast, Lough -	4.15	54.43		5.52
					Lambay Island. -	8.15	53.24		7.30

Coast

The variation is about two points W. all along the South and East Coast of England, 1774; and 24 deg. W. in lat. 60 deg. N. mer. of London.

Coast of Greenland, H.W.				Coast in the Sound and Baltic.			
	h. m.	d. m.	d. m.		Var.	Lat.	Lon.
Nova Zembla and Isles.					West	d. m.	d. m.
Shetland South Point	3.00	59.56 ^N	1.30	Mardou - - -		58.20 ^N	8.58 ^E
North do.	Var.	60.50	0.10 ^W	Christiania - - -		59.23	9.50
Hangcliff - - -	23.45	60.09	0.38	Gottenburg - - -	10.00	57.50	12.10
Entr. of Brasf Sound				Elfinore - - -		56.23	12.40
—Coast of Iceland.				Copenhagen - - -		55.40	12.50
Sound Royal - - -		66.22	14.30 ^W	Kalmer - - -		56.40	16.30
Bargazar Point - - -		66.20	16.32	Stockholm - - -		59.20	18.10
Whale's-back - - -		65.26	20.32	Wybourg - - -		60.50	29.12
Merchant's Foreland		63.24	17.05	Petersburg - - -	0.00	59.56	30.22
Halliford - - -		64.30	34.40	Narva - - -		59.26	28.20
Fair Foreland - - -		66.18	26.30	Revel - - -		59.24	24.50
Grim's Island - - -		67.13	22.32	Rigo - - -		57.00	25.10
Westmonia Isles. -		63.28	22.22	Derwinda - - -		57.12	22.00
Isles of Ferre, or Farro		62.04	5.00	Koningsberg - - -		54.40	21.30
Beerenburg, or Joan }				Dantzick - - -		54.22	18.36
Main's Isle.		71.30	4.30	Wisby in Gothland		57.30	18.25
—Coast of Greenland.				Bornholm - - -		55.12	14.40
Point Look-out, -	Var.	76.24	15.33 ^E	Strael Sound - - -		54.24	13.10
Horn-sound - - -	West	76.45	13.34	Lubeck - - -		54.04	9.50
Bell-sound - - -		77.12	12.45	Anout - - -		56.50	11.00
Charles Isle, Black Point		77.35	11.15	Lefou - - -		57.04	10.27
C. Cold, N end Charles I.	18.36	79.06	11.02	Coast of Holland and			
Isle Amsterdam -		79.40	12.45	Flanders.			
Fair Foreland - - -		79.18	10.50	Scaw - - -	H.W.	57.30	10.20 ^E
Hacluit's Headland	17.40	79.47	10.46	Helighland - - -		54.25	8.33
Cloven Cliff - - -	18.24	79.43	9.56	Hamburgh - - -	6.15	53.40	10.30
Muffin Isle - - -	18.13	80.19	11.20	Embden - - -	12.15	53.03	7.30
Black Point - - -	9.42	78.28	18.38	The Fly - - -	6.00	53.12	5.30
Table I. one of the 7	9.33	80.57	20.34	The Texel - - -	6.30	53.12	5.10
Smeerenburg - - -	18.53	79.44	11.48	Amsterdam - - -	3.00	52.22	5.15
Dunkins Isle in Vogel }	18.47	79.42	9.59	Rotterdam - - -	3.45	51.56	4.34
Sound - - -	20.38	79.52	12.30	Antwerp - - -		51.13	4.28
Hope Island - - -		76.15	23.40	The Brill - - -	1.30	52.00	4.00
Cherry, or Bear Isle		74.28	18.00	Ostend - - -	12.00	51.14	3.00
Admiralty Isle - - -		75.00	54.40	Royal Observatories, and places where			
Nova Zembla - - -		78.00	70.00	fit of Venus was observed.		Lat.	Lon.
Weigate Straits - - -		70.30	60.00	The *		d. m. f.	d. m.
Cape Candinose - - -		69.00	42.30	Greenwich Obsf. - - -		51.28.39 ^N	0.05 ^E
Cat Nose - - -		65.40	35.00	Admiralty - - -		51.31.00 ^N	0.02 ^W
Archangel - - -		64.34	38.06	Paris - - -		48.50.14 ^N	2.25 ^E
Cross Island - - -		66.30	36.30	Gottingen - - -		51.32.00	9.59 ^E
Sweetnose - - -		68.06	34.40	Leydon - - -		52. 8.40 ^N	4.31 ^E
Kilduyn - - -		69.24	31.20	Vienna, Imperial - - -		48.12.32 ^N	16.27 ^E
North Cape - - -		71.20	23.00	Alexandria, Egypt - - -		31.11.20 ^N	30.22 ^E
Surroy - - -		71.00	16.40	Bologna, Italy - - -		44.29.36 ^N	11.20 ^E
Tromsund - - -		70.20	15.26	Drontheim, Norway - - -		63.26.10 ^N	11.05 ^E
Læfort S. W. Point		68.10	9.28	Upsal, Sweden - - -		59.51.50 ^N	17.30 ^E
Dronthem - - -		63.48	10.12	Fornea, Finland - - -		65.50.50 ^N	24.16 ^E
Statland - - -		62.12	4.40	Tobolsk, Siberia - - -		58.12.12 ^N	68.18 ^E
North Bergen - - -		60.10	5.40	Madrid, Spain - - -		40.25.00 ^N	3.16 ^W
Naze of Norway. -	12.00	57.44	12.40	Rodrigues - - -		18 40.40 ^S	63.14 ^E

Coast

* Longitude from the Meridian of St. Paul's, London.

Coast of France.	H.W. h. m.	Lat. d. m.	Lon. d. m.	Coast of Spain within the Straits.	H.W. h. m.	Lat. d. m.	Lon. d. m.
Isle of Ushant - -	6.00	48.53 ^N	4.55 ^W	Athens - -	38.05 ^N	23.52 ^E	
Brest - -	3.15	48.23	4.26	Cape Martelo, S. part } of Negropont - }	38.06	25.00	
Penmark Point - -	3.00	47.50	4.20	Salonica - -	40.41	23.13	
Bell Isle - -	3.30	47.21	3.13	Cape Monte Sancto	40.26	25.00	
Angers - -		47.28	0.34	Gallipoly - -	40.32	27.20	
Rochell, - -	3.45	46.10	1.11	Constantinople - -	41.00	29.00	
Nantz - -		47.13	1.30	Smyrna - -	38.28	27.25	
Bordeaux - -		44.50	0.30	Ephefus - -	38.00	28.00	
Bayone - -	3.00	43.29	1.25	Antiochetta - -	36.30	32.45	
Coast of Spain.				Scanderoon, or Alex- } andrietta - - }	36.35	36.30	
Cape Ortegal - S	3.00	43.52	7.30 ^W	Antiochia - -	36.10	36.30	
Cape Pinas - -	3.00	43.41	5.50	Aleppo - -	35.45	36.25	
C. Corunna, or Groin S	3.00	43.28	8.15	Tortosa - -	35.46	36.00	
C. Prior - -		43.38	8.05	Tripoli - -	34.48	36.06	
C. Finistere - S	3.15	43.03	9.06	Joppa, or Joffa - -	32.45	36.00	
Ville del Conde - -		41.19	8.20	Jerusalem - -	31.50	35.25	
Oporto, or Porta Port P		41.05	8.06	Alexandria - -	31.11	30.21	
Bayonna - -	4.45	42.03	8.45	Cape Rufato - -	32.48	21.25	
Burlings - - P		39.36	9.10	Cape Misurato - -	32.20	16.20	
Lisbon - - P	2.45	38.42	8.53	Tripoli - -	32.54	13.10	
C. Roxent - - P	1.00	38.40	9.16	Susa - -	35.54	10.40	
C. St. Vincent - P		36.58	8.45	Cape Bona - -	37.04	11.00	
Cadiz - - S		36.33	5.56	Bona - -	37.00	8.20	
Cape Trefalgar - -		36.10	5.55	Algiers - -	36.50	2.18 ^W	
Gibraltar - - E	12.00	36.12	4.55	Cape de Tres Forcas	35.30	2.43	
—Within the Straits.				Ceuta - -	35.49	4.40	
Malaga - - S		36.42	4.00 ^W	Tangier - -	35.50	5.45	
Cape de Gat - -		36.40	1.40	Islands within the Straits			
Cape Paul - -		38.14	0.00	Formentaria I. - -	38.33	1.15 ^E	
Alicant - -		38.34	0.05 ^E	Ivica - -	38.53	1.15	
Cape Martin - S		38.45	0.30	Majorca - -	39.45	2.25	
Barcelona - - S		41.26	2.08	Minorca - -	39.45	4.20	
Marseilles - -		43.18	5.27	Fort St. Philips - -	39.51	3.53 ¹	
Toulon - -		43.07	6.02	Gallita Island - -	37.42	9.00	
Genoa - -		44.25	8.40	S. End of Sardinia - -	38.54	9.15	
Leghorn - -		43.30	10.30	N. End of Corfica	42.52	9.40	
Civitta Vecchia - -		42.05	11.50	Gorgona Island - -	43.22	9.10	
Rome - -		41.54	12.25	Captia - -	42.50	14.30	
Naples - -		40.51	14.20	Lilboa - -	42.45	11.00	
Cape Spartevento - -		37.54	16.50	Messina - -	38.20	16.20	
Cape Colonne - -		39.00	18.00	Maritimo I. Sicily - -	38.04	12.30	
Gallipoli - -		40.20	18.20	Cape Passero - -	36.36	15.20	
Cape St. Mary - -		39.48	19.00	Malta - -	35.54	14.35	
Ancona - -		43.40	14.20	Corfu Island - -	39.50	19.50	
Venice - -		45.25	12.09	Zephalonia - -	38.10	20.10	
Point Palerma - -		38.10	13.45	Zent - -	37.44	20.15	
La Valona - -		40.54	21.20	Morea - -	36.50	21.40	
Lepanto - -		38.10	23.00				
Cape Matapan - -		36.30	22.40				
Cape St. Angelo - -		36.30	24.00				

Western

Note. S after the name of a place, denotes it to be under the Spanish Govern. P Portugal, E English, D Dutch.

Western Islands, or Azores.			Coast of Barbary and Guinea.		
	Lat. d. m.	Lon. d. m.		Lat. d. m.	Lon. d. m.
Corvo - - - - P	39.48 N	31.20 W	Cape Formosa - - -	4.28 N	6.00 W
Flores - - - - P	39.24	30.20	Cape Three points - -	4.45	3.10
Fial - - - - P	38.40	27.00	River Voltas - - -	5.50	1.10 E
Tercera - - - - P	39.00	24.50	River Formosa - - -	6.10	4.50
St. George's - - - P	38.45	25.56	New Callabar - - -	5.00	7.00
Pico, or Pic of Azores P	38.36	26.20	Old Callabar - - -	4.30	8.10
St. Michael's - - - P	38.12	22.50	River Cammaroons - -	3.30	9.10
St. Marie's - - - P	37.00	22.56	River Angra - - -	1.00	9.35
Canary Islands.			Cape Lopez - - -	0.48 S	8.30
1. Porto Sancto - - P	33.06 N	16.05 W	River congo - - -	5.45	11.50
2. Madeira P East end -	32.50	16.26	Angola - - -	8.15	15.00
Do. - West end -	32.30	17.28	Cape Negro - - -	16.30	11.30
3. Palma - - - S	28.40	17.35	Cape St. Thomas - -	24.54	15.25
4. Teneriff, the Pic - P	28.25	16.25	The Cape Town - -	33.56	18.28
5. Gemara - - - S	27.57	17.07	Cape of Good Hope	34.30	18.45
6. Ferro, or Isle of Fer S	27.42	18.10	Cape False, or Hanglip -	34.34	19.15
7. Canaria - - -	27.53	15.38	Southern Islands, in the Atlantic.		
8. I. Fortune Ventura -	28.20	14.10	St. Mathews - - -	1.23 S	6.10 W
Seven others N. E. of this.			Ascension - - -	7.57	13.54
Cape de Verd Islands.			St. Hellena - - -	16.04	5.54
1. St. Anthony - - P	17.00 N	24.25 W	Fernandepo - - -	3.02 N	3.32 E
2. St. Vincent - - P	16.55	24.10	Princes - - -	1.48	6.40
3. St. Lucia - - P	16.53	24.00	St. Thomas - - -	0.00	7.00
4. St. Nicholas - - P	16.40	23.22	Cape podron - - -	6.00 S	11.40
5. I. of Sel - - - P	16.57	21.52	Annabona - - -	2.26	5.40
6. Bonavista - - - P	16.05	21.45	St. Philips - - -	12.22	13.20
7. Isle of May - - P	15.14	22.05	Tristian de Cunha - -		
8. Isle of St. Jaga - P	15.00	22.45	Isle de Picos - - -	37.10 S	13.20 W
9. Isle of St. Philip - P	14.50	23.22	I. Martinvas - - -	24.00	16.20
10. Isle of St. Jean - P	14.45	24.10	I. St. Maria - - -	21.00	18.40
Coast of Barbary and Guinea.			I. St. Maria - - -	20.00	18.40
Cape Spartel - - -	35.45 N	5.48 W	I. Trinidad - - -	20.30	25.30
Sallee - - -	34.00	6.20	I. Ascension - - -	20.40	28.30
Cape Cantin - - -	32.48	8.50	I. Fanando Noranha - -	3.50 S	30.35
Cape de Gear - - -	30.40	10.05	I. Rocas - - -	5.00	35.40
Cape de Nun - - -	28.15	11.06	I. Sebalde - - -	50.53	59.35
Cape Bajadore - - -	26.28	14.22	A TABLE of the Lat. Lon. and Vari. where there has been no change or mutation of the Variation for many years.		
Cape Olerado - - -	23.28	15.50	Lat.	Lon.	Vari.
Cape das Barbas - - -	22.06	16.43	0°	40° W	3° 30' E
Cape Blanco - - -	20.46	16.52	5 N	5	13.00 W
Cape Mirick - - -	19.12	15.30	5	30	1.30 W
Mouth of Senegal River -	15.36	16.20	5	35	0.30 E
Senegal - - -	16.36	12.40	5	40	2.15
Cape de Verde - - - E	14.42	17.05	5	45	4.00
Mouth of River Gambia -	13.20	15.00	10 N	50	4.00
Cape Rouge - - -	12.12	16.18	15	60	5.00
Mouth of River Sierralion	8.30	12.12	20	70	5.00
Cape Monferado - - -	6.28	9.30	25	65	2.15
Cape Palmas - - -	4.25	6.00	30	84	0.00

H

NORTH

And by observations of several commanders of ships who have sailed in Hudson's Bay about the lat. 60 deg. N. and lon. 65 deg. W. their compasses have whirled about in a strange manner, by which it may be supposed, that they were affected by the magnetic matter in that part of the Bay.

NORTH AMERICA.		Lat.	Lon.	Coast of Carolina, Virginia, Maryland, Pennsylvania, New-England and Newfoundland.	
		d. m.	d. m.		Lat. Lon.
Sir Thomas Smith's Sound		78.30 N	63.30 W		d. m. d. m.
Digg's or Dudley's Cape -		76.50	59.00	Cape Roy - - - E	47.40 N 57.00 W
Hackluit Island - -		77.25	59.30	Placentia - - - E	47.38 52.00
Alderman Jones's Sound -		77.30	89.00	Cape St. Mary - - E	46.54 52.20
James Lancaster's Sound		74.10	90.00	Cape Race - - - E	46.50 51.00
Baffin's-bay James's-Isle -		71.40	57.30	Bay of Bulls - - E	
Baffin's-Straits, Cumberland I.		68.00	62.30	Louisbourg - - - E	45.54 59.50
Hudson's-bay Islands.				St. John's Harbour - E	48.00 50.15
I. of Good Fortune - -		65.00 N	67.30 W	St. John's Fort - - E	47.32 52.43
King Charles's Cape - -		65.00	77.30	Conception Bay - - E	48.24 50.20
—At the Mouth of Hudson's Straits.				Trinity Bay Entrance - E	48.54 50.30
I. of Resolution - -		61.40 N	64.30 W	Cape Bonavista - - E	49.34 50.20
Chidley I. - - -		60.40	63.30	Cape St. John - - F	50.24 52.45
In the Straits, I. Salisbury		63.30	75.00	Bell Island - - - E	51.50 51.30
I. Nottingham		63.30	77.00	Bay of Brest - - -	52.10 52.40
I. Southampton		63.30	82.30	Cape Blanco - - -	47.20 70.00
I. Mansels		62.00	79.00	Quebec - - - E	46.55 69.48
Repulse Bay - - -		67.56	84.40	Cape Britain - - E	46.30 58.00
Cape Dobbs - - -		65.35	84.45	Straits of Monfac, Nova Scotia	45.39 61.20
Bowden's Inlet - - -		64.30	94.00	Isle Sable - - - E	44.16 59.00
Marble Island - - -		63.00	91.45	Cape Sable - - - E	43.24 65.25
Prince of Wales's Fort, } Churchill River - }		58.48	94.12	Bolton - - - E	42.25 70.32
York Fort, Nelson River *		57.36	93.10	Cape Cod - - - E	42.14 69.00
Cape Tatnam - - -		58.00	91.00	New York - - - E	40.43 74.04
Cape Henrietta - - -		55.22	83.00	Long Island - - - E	41.00 73.00
Coast of Labrador.				Cape May - - - E	39.15 74.45
Cape Britton, West end of } the I. of Button - - }		60.20 N	62.30 W	Cape Charles - - E	37.12 76.00
Cardinal's Isles - - -		58.50	61.40	Cape Henry - - - E	37.00 76.23
St. Peter's Haven - - -		56.36	59.50	Cape Hatteras - - E	35.10 76.00
Gantin Bay - - -		57.10	61.30	Philadelphia Town -	40.10 75.04
Coast of Hudson's Bay and Straits.				Cape Lookout - - -	34.25 77.00
Cape Farewell - - - E		59.40 N	44.30 W	Cape Fear - - -	33.49 78.00
Q. Anne's Foreland - E		64.06	74.40	Charles Town on Ashley Riv.	33.21 79.48
Shark Point - - - E		64.10	82.15	Port Royal South Carolina	32.20 80.25
Cape Southampton - - E		61.55	86.20	Bay of St. Augustine -	29.52 80.34
Cape Churchill - - - E		59.00	95.30	Cape Canival Reefs -	28.16 80.45
The Cubbs - - - E		54.16	82.35	Key Largo - - -	25.00 81.43
Albany River - - - E		52.36	85.20	Cape Florida - - -	25.07 81.25
Charlton I. - - - E		52.03	80.05	Dry Tortugas, Southermost	24.30 85.10
Rupert's River - - - E		51.40	78.50	—Northernmost	24.38
Cape Jones - - - E		55.10	79.00	Key Market, W. Key, S. end	24.36 84.24
Mansfield's Isle - - E		61.45	80.30	Ent. of Spir. Sancto harbour }	
Cape Walsingham - - E		62.40	78.00	in E. Florida (var. 5° 45' E }	27.40 83.49
Cape Charles - - - E		62.20	74.45	Cape Blaze - - -	29.41 86.25
				St. Joseph's Point - -	29.55 85.28
				Entrance of St. Andrew's bay	30.08 86.45
				The Cliffs 2 miles W. of it †	
				Cape St. George - -	29.37 86.07
				Penfacola Town - -	30.29 88.22
				Penfacola Bar - - -	30.19 88.25 ¹

* Nelson R. runs from Winipigon lake (Lat. 49 deg. N. Lon. 102 W.) from which lake there is a large river which runs to the Pacific Ocean, and joins it in Lat. 44¹/₂ deg. N. Lon. 130 deg. W.

† There is a large square grove, at the Foot of which is a low red bank, 4 leagues W. of St. Andrew's Bay and 12 leagues East off Rose Island;

Coast of Carolina, &c.			Caribbee Islands.		
	Lat. d. m.	Lon. d. m.		Lat. d. m.	Lon. d. m.
Rose Island, West end -	30.20N	88.05W	Anguilla - - - E	18.15N	60.00W
Entrance of Mobile River	30.10	87.37	St. Martin's - - -	18.05	62.30
Dauphin Island - - -	29.41	87.54	St. Bartholemew's - E	17.52	62.35
Ship Island Bay - - -	30.30	88.20	Barbuda - - - E	18.05	61.35
New Orleans - - -	29.58	89.55	St. Christopher's - E	17.15	62.50
Entrance of the Mississippi	29.10	89.32	Nevis - - - E	16.55	62.40
Candlemas Isles or Chandineers the N. part of the N.ermoft	30.02	89.06	Antigua - - - E	16.56	61.50
Jucosa Bay - - -	29.18	94.15	Monferat - - - E	16.36	62.12
Bay of St. Bernard - -	28.15	95.45	Guardalupe - - - F	16.20	61.25
Port Blanche in the I. of Labos	21.48	97.16	Marigallalte - - - F	16.00	61.00
Mexico City - - -	20.00	103.35	Dominico - - - E	15.15	61.10
La Vera Cruz - - -	19.05	98.30	Martinico - - - F	14.44	60.57
Campeche Bay.			St. Lucia - - - F	13.45	61.10
Point St. Martin - - -	18.30N	96.00W	St. Vincent - - - E	13.10	61.00
Tabasco Isle, N. Point -	18.00	92.36	Barbadoes, Bridge Town E	13.05	59.45
Bay of Port Sumacenta -	17.50	91.45	Willoughby Fort - - -		
River Lagarto's Mouth -	21.15	88.15	Granada - - - E	11.52	61.40
Musketo shore from C. Ca- toche to Cape 3 Points in the Gulph of Honduras }	21.34 15.36	87.00 89.36	Trinidado - - - S	10.38	60.30
Cape Bafer, Ascension Bay	17.39	88.30	Virgin Gorda Fort - -	18.18	63.50
Cape Honduras - - -	16.06	85.34	Virgin's I. - - -	18.28	64.40
Coast of Honduras			St. Cruz - - - F	17.55	65.00
Cape Comaron - - -	16.04N	84.00W	Bieque - - -	18.00	65.30
Santa Morfac - - -	10.57	83.12	—Porto Rico.—		
C. Graciosa Deos var. 11°. 16' E	15.04	82.00	St. John's - - - S	18.30	67.10W
Porto Bello * (var. 9° 45' E)	9.33	78.52			
Bahama Islands.			The Latitudes and Longitudes of Places in the WEST INDIES, as determined by Capt. Barnaby, Commander of the Zephyr Sloop of War, in the Years 1771, 1772 and 1773, by CELESTIAL OBSERVATIONS.		
North part of Bahama Bank E	27.45N	79.40W		Lat. d. m.	Lon. d. m.
Bahama Island - - - E	26.42	79.10	Bridge Town, Barbadoes	13.08N	59.50W
Abacco, South Point - E	26.15	78.50	North part of do. -	13.34	60.00
Harbour Island - - - E	25.20	77.37	Tobago, N. E. part - -	11.21	60.15
Andrass, North Point - E	25.00	79.40	Curasso, E. end - -	12.12	61.30
Providence - - - E	24.50	78.08	Sugarloaf Hill in the Isle of }		
Illathera, South Point E	24.55	76.45	Auruba (var. 8°. 05' E) }	12.33	70.00
Cat Island, South Point E	24.00	76.00	Bermuda S. point (va. 4°. 30' W)	34.14	64.45
Rum Key - - - E	23.00	74.20	San Domingo - - -	18.25	69.29
Exuma - - - E	23.25	75.34	Altavella - - -	17.28	71.08
Crooked Island, N. Point E	22.46	73.50	Cape Francis, Hispaniola	19.59	71.35
Atkin's Key - - - E	22.06	73.45	San Bay, do. - - -	18.04	71.55
Meraparovuz River - E	22.00	74.10	Port au Prince (var. 8°. 00' E)	18.38	72.15
Atwood's Key - - - E	21.22	72.40	Port Piment, Hispaniola	18.08	73.41
French Key - - - E	22.30	73.40	Plat Form. do. - - -	19.36	72.58
Hogflies - - - E	21.40	73.15	Isle of Ash, S. W. part	18.04	73.08
Heneago - - - E	21.07	73.00	Port Louis, Hispaniola -	18 19	73.00
Caico's Bank, North Point	21.50	71.50	N. E. end of Jamaica -	18.25	75.49
Turk's Island - - -	21.45	70.30	Eastermost part of do. -	18.02	75.40
Abrolho, North Point	21.34	69.40	Port Royal, do. (var. 6°. 30' E)	17.53	76.36
Plate Wrack River -	20.04	68.40	Morant Keys, do. - - -	17.29	75.27

S. E.

* The Isthmus of Darien which joins Nor. and Sou. America, is 70 miles wide from Panama to Porto Bello.
N. B. The I. of Ferro is the Westernmost of the Canary Isles, and it is 20 deg. W. from Paris, or 17 d. 30 m W. from London.

Obfer. by Capt. Barnaby, &c.	Lat. d. m.	Lon. d. m.	Coaft of Wild Brazil.	Lat. d. m.	Lon. d. m.
S. E. part of Port Morant	17.54N	76.02W	I. St. Juan - - -	1.20S	45.00W
Formagos - - -	18.24	76.30	Mouth of the River Omara	5.00	34.55
Cape Mays, E. end of Cuba	20.15	74.50			
Cape Antony, W. end of do.	21.50	85.00			
Cape Catoche Jucaton, New } Spain - - -	21.34	87.00	Coaft of Brazil, Paragua and Patagonia.		
Havanna in the I of Cuba S } (var. 4°.00 E) - - -	23.12	81.41	I. Ferdinando Loronho -	3.48S	30.50W
St. Jago - - - S	20.03	75.51	Cape Roque - - -	5.00	35.45
I. of Pines, S. W. point -	21.32	82.45	Cape St. Auguftine - -	8.50	35.10
Pine's Bay (var. 6°.24' E)	21.44	83.30	River St. Francisco - -	10.55	36.40
Lowland in the I. of Pines * } which is due S. from the middlemoft of the three high Hummocks - - -	21.29	83.30	Bay of Todos Sanctos -	13.05	39.00
Middle high Hummock -	21.46	83.30	Port Segura - - -	17.00	40.00
Point Irois - - -	18.28	74.17	Spirito Sancto - - -	20.20	40.00
Ile of Navafa - - -	18.26	74.36	Rio Janero - - -	22.54	42.40
Cape Donna Maria - -	18.45	74.14	Cape Frio - - -	23.00	40.20
Cape Tiberon - - -	18.22	74.07	St. Catherine's - - -	27.46	48.00
Point Dabacou - - -	19.57	73.10	River Grand - - -	32.00	50.40
Mole Head - - -	19.47	73.11	River Plate - - -	36.00	57.40
Cape Nicholas - - -	19.43	73.10	C. Blanco near Ri. Camaroons	47.00	64.00
I. Gonave, S. Point of W. part	18.51	72.53	Port Defire, to make it with Steeple Rock on the S. } fide of it - - -	47.30	64.40
I. of Tatuga, } N. E. part or Tartudas } W. part -	20.10	71.59	Pepys Ile could not be found by Commodore Byron.		
I. Mayaguana, E. end. -	22.29	72.30	River Julian - - -	48.45	65.00
Watling I. North part -	24.10	76.00	Cape Virgin Mary - -	52.21	71.44
Key Sal - - -	23.45	80.43	Straits of Magellan, Entrance	52.50	72.35
			Staten Island - - -	54.30	69.00

S O U T H A M E R I C A.

	Lat. d. m.	Lon. d. m.		Lat. d. m.	Lon. d. m.
Carthagen (var. 8° E) -	10.26N	75.25W			
Cape Agua - - -	11.32	74.10			
St. Martha - - -	11.22	74.00			
Cape de la Velle - -	12.18	71.45			
I. Arcuba - - -	12.45	69.52			
I. Curacoa - - -	12.12	69.06			
I. Blanche - - -	12.15	64.15			
Coaft of Comana C. 3 points	11.15	62.44			
Dragon Entrance - -	11.10	62.15			
Gulph of Paria, Trinity I. } or Trinidad - - -	10.30	61.30			
Mouth of River Oronoco	8.30	60.30			
—Coaft of Guiana.					
Surinam - - -	6.00N	55.50W			
Cayenne - - -	4.56	52.10			
Cape Orange - - -	4.10	51.05			
North Cape - - -	1.40	50.10			
Mouth of the River Amazons	0.40S	48.10			

The Western Coaft of Patagonia and Chili,
which bounds the Eastern Part of the Paci-
fic Ocean.

	Lat. d. m.	Lon. d. m.
C. Difcada and the Twelve Apostles - - -	53.10S	79.30W
W. entr. of Magellan Straits	53.00	79.00
The Four Evangelifts off } C. Victory - - -	52.20	80.30
C. St. Catalina - - -	51.33	80.20
Com. Anfon's watering har- bour - - -	46.00	77.45

* Which is the Southermoft part of the Ile of Pines.

Coast of Chili. America.	Lat. d. m.	Lon. d. m.	Asiatic Isles.	Lat. d. m.	Lon. d. m.
I. Mocha - - -	38.30S	78.06W	Jeso Islands between 41°N. and 140° E. and -	45.00N	150.00E
Valparaíso - - -	33.20	77.15	Sea of Ochozk, or Lama, 52° N. 138° E. and -	63.00	160.00
Juan Fernandes I. - -	33.30	84.00	Isles of Nipon, where Capt. Sprangberg made it.—	40.00	143.30
Coquimbo - - -	30.00	77.00	This is a large Island between 34 and 41°N. -		
I. Salado, in Salt Bay -	26.30	74.30	Japan S. of Nipon. See p. 38.		
—Coast of Peru.—			On the West Coast of Africa.		
Gouano I. - - -	21.00S	75.20W	Saldanha bay - - -	30.09S	17.40E
C. Congallon - - -	14.15	79.00	Coney Isle - - -	33.25	
Lima city - - -	12.01	77.00	Penguin Isle - - -	33.49	
C. Blanco - - -	4.00	81.05	Table Bay - - -	33.54	
C. S. Helena - - -	2.20	81.20	Table Land - - -	34.04	18.45
C. St. Francis - - -	0.45N	81.00	Cape Town and Fort -	33.56	18.28
Bona Ventura Bay - -	3.30	77.00	Chapman's Bay - -	34.03	
C. Corientes, Co. of Popayan	4.20	78.20			
Panama - - -	8.45	80.30	The Eastern Coast of Africa, beginning at the C. Good Hope.	*	
Point Mala, Co. of Varagua	7.00	81.00	C. Good Hope - - -	34.22S	18.45E
C. St. Catherine - -	11.00	88.30	Simon's Bay, in False Bay	34.12	18.45
C. Remedie - - -	12.50	93.00	Hanglip Point - - -	34.16	19.00
Acapulca - - -	17.10	104.30	Note, that C. Good Hope and Hanglip Point make the mouth of False Bay.		
C. Corientes, Co. of Guatemala - -	19.45	110.00	Cape False - - -	34.34	19.10
St. Thomas I. - - -	20.10	113.00	Cape Anguillas - - -	34.44	20.32
—Coast of California.—			A cape and rocks off shore	34.18	23.50
C. Concepcion - - -	36.00N	126.00W	Confused Islands - -	34.00	25.40
C. Mendocin, disc. by Sir F. Drake, in the year 1578, New Albion	42.20	130.00	Cape Pedras - - -	30.15	29.05
Mouth of the River of the West, disc. in 1603, by M. d'Aquilar, said to join Nelson R. Hudson's Bay	44.30	131.00	Cape Fumas - - -	27.27	31.05
Coast disc. by Capt. Tschirikow in 1741, and by C. Bering in 1741, from	55.00 to 60.00	137.00W to 140.00E	I. St. Mary's, N. point, at the entr. of Delagoa Bay	20.04	31.10
C. St. Elias - - -	59.10	146.30W			
C. St. Hermogenies - -	58.45	154.20	Coast of Sofala, Mosambique and Quirimbo.		
I. of St. Stephen at the mo. of the sea of Komschatka	50.45	180.25	English River, in the Bay	25.45S	30.10E
Bering's I. where he was cast away, and died; said to be 5° West from the Coast of America. -	55.35	190.00W to 170.00E	C. Corientes - - -	23.58	34.00
—Sea of Anadir.—			C. St. Sebastian - -	22.41	36.30
I. of St. Lawrence (C. Bering discovered - -)	64.00N	173.30W	Mouth of the River Cuama	18.12	36.10
The neck of the sea between Asia and America, from coast to coast, 4°.20', or 35 leagues = 105 miles	66.00	170.00W	Angoxa - - -	16.00	39.11
Sedition Isles - - -	50.40	166.00E	Mosambique - - -	15.08	40.33
South point of Kamtschatka	51.03	157.00	Quirimbo - - -	12.22	40.50
Kurilian Isles between 45° N. and 152° E. and	51.00	157.00	C. Delgada - - -	10.10	41.12
			I. St. Christopher - -	17.00	42.18
			I. Mayotta - - -	13.00	44.53
			I. Johanna - - -	12.18	44.20
			I. St. John de Nova -	10.10	51.15
			* H. W. full and change at half past 2. Tide flows 3 feet.		

Bay

† From 137 d. W. to 140 d. E. is from 137 d. W. to 220 d. W. from London; which 220 is 140 E.

The coast of the I. of Madagascar.		Lat. d. m.	Lon. d. m.	Coast of Persia.		Lat. d. m.	Lon. d. m.
The Western coast is bad to be approached, there being so many rocks, sandbanks and small islands, which extend in some parts to 80 miles W. from the coast between the lat. 16 and 18° S. See the chart.				Gianto S. Point - - -		22.24E	69.15E
Bay of St. Augustine -	23.23S	42.55E		Cambay on the coast of } Concon - - - }		22.14	72.50
Star Bank - - -	25.30	42.15		Surat - - - -		21.10	72.52
C. Maria S. point of the Isle	25.45	20.53		I. of Bombay - - -		19.10	72.55
C. Moneo on the E. coast	25.30	23.17		Elizabeth Bank - - -		17.00	71.20
Trading place in Littleton's Bay - - - }	16.45	26.01		Goa, Coast of Canaro		15.25	74.45
I. St. Lucia - - -	24.40	23.55		— Coast of Malabar.			
Foul Point watering place	17.46	0.00		Oyster Rock before Carwar		14.55E	73.50E
I. St. Mary's - - -	16.46	26.05		E. Tillicherry - - -		11.48	75.25
Antongill Bay - - -	15.45	26.05		E. Callicut (in the Bay) -		11.15	75.45
C. St. Ambre - - -	11.46	25.50		E. Aujanga - - -		8.30	76.46
A Bank in lat. - - -	37.34	15.45		Cape Camaroon - - -		7.56	78.35
I. Mascarinhas - - -	20.46	32.00		— Isle of Ceylon or Zeloan.			
I. Mauritius - - -	20.30	34.15		Gulf of Manara (Manara I.)		9.03E	78.00E
I. Diego-roya, or Bay -	19.43	39.45		Koppen Point - - -		9.15	79.30
The Seven Brothers -	3.30	36.30		Crankanella Bay, on the } E. side of Zeloan - }		8.33	81.30
Small Islands at the Equator	0.00S	47.13		Adam's Peak, W. side		7.20	80.36
Coast of Anjan, C. Basses	4.30N	26.20		Point Pedro, at N. end -		9.41	80.52
I. Soccatra - - -	12.25	31.15		Point Gaula, or Galla -		6.00	81.24
C. Guardafoy - - -	11.36	29.00		— Coast of Coromandel.			
H. W. at 3 hours on the full and change days.				E. Fort St. David - - -		11.42E	80.20E
The water rises about 4 ft.				F. Pondicherry - - -		11.57	80.25
The eight Isles at the mo. of the Straits of Babel-mandel - - - }	12.36	44.25		E. Madras - - -		13.13	81.00
I. Babel-mandel in the Straits	12.55	44.22		Point Gordeware - - -		16.32	80.52
— Coast of Arabia.				E. Point of Palmiras -		20.45	88.00
Mocha City - - -	13.35	44.20E		E. Ballasore, the road -		21.06	87.30
I. of Comaron in the Red Sea	15.30	43.48		Mouth of the River Ganges		21.30	88.30
River Bardilloy - - -	21.50	38.52		Calcutta on the Ri. Ganges		23.00	88.20
Mount Sinai - - -	28.45	35.15		Laccadive Isles, between } lat. 8 and 14° N. and }		—	71 to 74. E
C. Fortuack - - -	15.22	53.30		Maldiva Isles, between lat. } 0 and 7½° N. and - }		—	72 to 75. E
C. Roselgate - - -	22.10	60.37					
C. Moseldom at the entr. of the Persian gulf - }	26.12	57.15					
I. of Samake - - -	26.36	50.45					
Mouth of the R. Euphrates	30.20	50.15					
— Coast of Persia.							
Point Angero - - -	28.45	52.25E					
I. of Kishme - - -	26.36	56.30					
C. Jaques - - -	25.43	57.57					

EAST INDIES. The Latitudes of the Coasts, Capes, Islands, &c. from the Straits of Malacca, to Pekin in China, and Japan.

	Lat. d. m.	Lon. d. m.
Northernmost of the Nicobar Islands in - - - }	6.45N	and
from Madras - - - }	- -	12.00E
Islands off the N.E. coast of Sumatra and off the S.W. co. of Malay, which coasts make the Straights of Malacca—The N. entrance.		
Diamond I. co. Sumatra	3.00	95.20E
Point Pera, coast of Malay	5.40	96.30
I. of Arroas co. of Sumatra	2.48	98.00
Malacca City. Dutch	2.12	100.00

Note. Where E stands before the name of the Place, it denotes there is an English factory.

EAST

EAST INDIES.		Lat.	Lon.	Coast of Tonquin China.		Lat.	Lon.
		d. m.	d. m.			d. m.	d. m.
Tide flows NNE. and SSW.				Cape Patience - - -		49.00N	147.00E
And the flood runs ESE.				Company's Land: S. point		46.20	152.00
ebbs WNW. Var. $1^{\circ}\frac{1}{2}$ W.				—Philippine Islands.			
Port Pisang, coast of Malay		1.16N	100.48E	I. of Luconia, C. Bajadore		18.30N	117.53
Point Romania, do. var. $\frac{1}{2}^{\circ}$ W		1.23	102.55	C. Boulinao		16.12	117.00
White Rock at the S. entr.		0.54	102.06	Macclesfield Shoal - - -		15.15	112.30
Point Timooan*, E. coast				Bank of Marfingola - - -		15.23	116.15
of Malay - - - }		2.50	103.40	Goat I. or Cabre - - -		13.50	117.08
Pulo Arroes. Rocks be }				I. of Mindora, W. point		13.10	117.34
tween $2^{\circ}.40'$ and - }		2.50	va. 20° W	I. of Paragoa, N. point		11.15	115.50
See Nicholson's remarks from				Manilla† City. (Dutch)		14.39	120.00
p. 70 to 82.				Bay of Manilla - - -		14.40	118.10
In the Gulf of Siam, Po. Way		9.42N	100.30E	Borneo I. St. Peter's Mount		7.15	112.35
Siam City - - -		14.20	98.20	Point Dalto - - -		2.50N	107.00
Pulo Condore*, S. of the }				I. of Billiton - - -		2.32S	105.12
River Oube - - - }		8.40	105.40	Po. Salatan, S. pt. of Borneo		4.20	111.35
Cambodia City - - -		12.46	102.46	E. point of Borneo		0.06	115.15
There is a low Isle in -		11.28		I. Summatra, S.E. point		5.45	102.48
and $5^{\circ}.12'$ E. m. dist. from				Do. S.W. point		5.50	101.35
Pulo Sapata				Java I. St. Nicholas' point		5.45	103.15
—Coast of Cochin China.—				Java Head, the W. point		6.40	102.25
Comeryn Bay - - -		12.02N	107.15E	Batavia, Java I. (Dutch)		6.13	104.27
Isle S. off the tier of rocks,				Princes I. in the Str. of Sunda		6.20	102.20
and off the Paracells }		12.20		Christmas I. - - -		10.25	102.15
Pulo Sapata - - -		9.54	108.00	Coco I. - - -		12.30	93.50
A dangerous shoal off Goat }				Java I. E. point - - -		8.35	111.54
Island, in - - - }		11.30	112.00	—Coast of Terra de Paphos,			
Po. Canton, (Isle) -		15.37		Nova Guinea.			
The Triangles, 6 rocks bet.		16.17		I. Sebootons - - -		1.00S	134.00E
Haynan I. at the entr. of }				I. Moa - - -		1.30	137.30
the Gulf of Tonquin. S. po. }		18.05		Burning-Hill - - -		3.27	
—Coast of Tonquin China.				Nova Britania, disc. in 1700.			
Nightingale I. - - -		20.13N	00.00E	Dampier's Straits - - -		6.20	148.00
Tunking, or Tonquin -		31.30	110.00	Bat bay - - -		7.00	140.30
Canton - - -		23.11	113.00	Batavia - - -		11.00	143.30
I. of Lamoch - - -		23.09	117.34	Cape Vanderlin - - -		14.50	136.30
Chappel I. - - -		24.11	118.33	False Cape - - -		7.50	137.30
I. of Mananishen - - -		25.23	119.57	Cloets I. - - -		22.30	108.40
I. of Limo - - -		26.40	120.40	St. Francis' Island - - -		32.20	129.00
I. of Sampo Anna - - -		28.12	121.18	St. Peter's do. - - -		32.36	132.00
I. of Patkehecock - - -		29.45	122.22	—Van Diemend's Land§			
I. of Formosa, N.W. point		25.33	121.40	Wit's Isle - - -		41.45S	139.00E
C. de Liampo - - -		28.40	121.50	South Cape - - -		42.55	141.30
Nanking - - -		33.30	120.00	Vander-lin's I. - - -		40.40	145.00
Sandy Point, W. coast of }				New Zealand, 3 Kings I.		34.20	170.00
Formosa - - - }		24.02	120.27	Prince William's Islands		22.00	178.00W
Piscadore I. - - -		23.30	119.38	Isles of Rotterdam - - -		20.00	173.00
Peking, or Pekin - - -		39.00	118.00	I. of Tuberones - - -		12.00	173.30
Japan, S.W. point - - -		34.20	130.00	Waterland Isle - - -		14.40	149.00
N.E. point, called N. Cape		40.20	144.00	Fly Island - - -		14.55	151.00
Yedso, Cape Eraen - - -		42.00	145.00	Dog Isle - - -		14.55	142.00
Staten Island - - -		45.30	150.00	Ota Heita, or K. G. Island.		17.29	149.23

* The course from Timoon to Pulo Condore, is N. 19 deg. E. 122 leagues. To fall into Manilla Bay, see Directory, p. 84 to 86.—Directory, p. 83. He says, the English Pilot contains one continued error.

† Its Governor has the Government of all the Philippine islands. § Discovered in 1642.

AN account of the Russian Discoveries, comprehending the North part of the coast of Asia, from Nova Zembla, round the Tchutkschi, to the Isle of Japan; with the course of the three Russian ships which sailed from the river Lena. This river takes its name in the country Buriati in Siberia, near the lake Baikal, lat. 55° N. lon. 107° E. It runs (winding) about many thousand miles, and falls into the Frozen Ocean in various branches, near the isle Kyrak, in lat. 72° N. lon. 123° E. The North point of Samojud land, of the Muscovitish territories, in 78° N. and 93° E. which is 23° E. from Nova Zembla, and in the same parallel of latitude.

The Russian ships took their departure from Bykowskoi, neck of land, in 1648*, they passed among the ice, and mostly within sight of land, towards the East, between the latitude of 72 and 73° N. till they got to the lon. 175° E. from London; there the land stretched towards the North, which they passed in lat. 75° N. and in lon. 190° E. The land then tended S. and S.E. where they sailed to the Isle of St. Lawrence, and so on to Cape Kamtschatka, lat. $56^{\circ}.20'$ N. lon. 160° E.

* Note. The Pagan people of Jakutski sailed round, about 70 years before the Russians.

The Russian Discoveries were made from the year 1736 to 1742, from Nova Zembla, along the Frozen Ocean, to Japan. But the Jakutski (Asiatic) Russians, in 1648.

In the year 1736, while the officers of the ships were at the city of Jakutsk, they observed in the archives of the town, the voyage which had been made by them 70 years before.

In the Spring of 1726, Capt. Bering sailed down the river Lena to Jakutsk with Lieut. Spangberg; the Lieut. went before the rest upon the river Aldan, Maca, and Judoma: He was followed by Capt. Bering by land, with another part of the provisions, on horseback; they left Lieut. Tschirikow at Jakutsk, to bring the rest from thence to Ochotzk. Lieut. Spangberg was frozen up in the river Judoma: He set out the 4th of November, to proceed over land to Ochotzk; but suffered much by hunger, so as to eat leather bags, straps and shoes, and arrived the 1st of January, 1727. In the beginning of February, he returned to Judoma.

On the 20th of July, 1728, Capt. Bering and the Lieutenants set sail in three vessels, from Kamtschatka, lat. $56^{\circ}.32'$ N. lon. 164° E. The 10th of August, they got to the I. of St. Lawrence, and thence proceeded to $67^{\circ}.30'$; they returned, and arrived in the river Kamtschatka the 20th of September, and wintered there.

In 1737, Commodore Bering was at Ochotzk, and built two packet boats, and vessels to take provisions for their intended voyage: All were finished in the Summer, 1740. But in 1738, Capt. Spangberg sailed from Ochotzk in company: He sailed first towards Kamtschatka; and then towards the Kurilian Islands, he sailed to lat. 46° N. and then returned to Kamtschatka: The following Summer, they sailed to the Kurilian and to Japan; and then returned to the Commodore at Ochotzk. Capt. Spangberg and Capt. Walton, who had been separated at sea before they made Japan, and at different parts, unknown to each other, gave like accounts of its inhabitants, &c. and they made it to lie between 11 and 12° W. from Kamtschatka. Spangberg made it in lat. $38^{\circ}.51'$ N. and Walton in $38^{\circ}.17'$ N. They anchored in $38^{\circ}.20'$, and they were then, by account, $11^{\circ}.45'$ from the first Kurilian I. They continued near the coast, to $33^{\circ}.48'$ N. where they sailed into a harbour and went ashore to a city, and they were kindly received with marks of friendship.

The 4th of June, 1774, Commodore Bering and Capt. Tschirikow began their voyage from Awatscha, their ships were separated by a violent storm and fog on the 20th, and they were thereby deprived of mutual assistance. The Commodore did all in his power to find the other ship, but all in vain; as Tschirikow had taken an E. course from 48° N. and the Commodore from 45° : However they both made the American coast, and their accounts agreed very well. The 18th of July, the Commodore made it in lat. $58^{\circ}.28'$ N. and 50° E. from Awatscha. Capt. Tschirikow made it the 15th, in 56° N. and 60° E. lon. from Awatscha. On the 27th of August, Lieut. Waxel arrived at Awatscha in Kamtschatka, in lat. $53^{\circ}.50'$ N. where Capt. Tschirikow had arrived.

GEO-

* In the year 1636, the Cossacs of Jakutsk began to navigate the Frozen Ocean, in the rivers Jana, Indigirka, Alasea, and Kolyma, towards the East; and in 1646, they sent a company of volunteers, who found a navigable channel between the ice and the coast: they travelled to the river Anadir.

One of the three ships passed about the N.E. part of Asia, in 1648, in lat. 75° d. N. and 190° d. E. lon.

Of the EAST INDIES.

1. **T**HE empire of the Great Mogul. 2. The Peninsula of India, West of the Ganges; Malabar on the W. and Coromandel on the E. 3. The Peninsula, East of the river Ganges, to China; the Malay coast having the bay of Bengal on the West; and the coast of Cochinchina, with the bay of Tonquin, on the East; and the S.E. and S.W. coasts of Cambodia make, with the coast of Malacco, the bay of Siam. 4. The islands in the Indian Ocean.

Before the Europeans found the way to India, by sea, all the traffic was carried on by the Persians, Arabians and Moors, who brought the jewels, silks, spices, &c. partly over land, and partly by the Red Sea, to Alexandria, and other ports in the Mediterranean; whence the Venetians, Genoese and Florentines brought them to Europe; by which trade the Princes of Syria, Arabia, and Egypt, and the merchants of Italy, were greatly enriched. The Portuguese, having found the use of the compass, by which they sailed and found out all the coast of Africa, doubled the Cape of Good Hope, and found their way to the East Indies. Emanuel, King of Portugal, fitted out four ships and 160 men, who sailed from Lisbon in 1497, under the direction of Vasco de Gama, who doubled the Cape, and sailed to Mozambique on the E. coast of Africa, in lat. 15° S. After some time they sailed from thence, and in two months after they discovered the coast of Malabar; they anchored near Calecut, the 20th of May, 1498, where he sent some men ashore, who met with a Moor that understood Portuguese, and by his means the Zamorin, Emperor of Calecut, was informed of them: The Prince received them kindly; but being informed by the Moors and Arabians, that, if encouragement was given to the Portuguese, they would traffick no more with them; therefore, De Gama returned home, without settling the friendship desired, and arrived at Lisbon in September, 1499.

In the Year 1500, the King of Portugal sent out 13 ships and 1500 men; six of them arrived at Calecut, and were kindly received by the Zamorin; and a house was given to the King of Portugal, and liberty granted to load their ships before any others; but the Moors bought up all the goods; whereupon the Portuguese took the goods from the Ships of the Moors, as also from 10 Arabian ships in the port, and battered the Town with his cannon. He then sailed to Cochin, where he was kindly receiv'd, and furnished with the goods he wanted; and returned with rich cargoes to Lisbon, in August, 1502. The Portuguese carried on this trade with great Success many years, till the English and Dutch tried for a share, and made war with the Portuguese. The Dutch, in 1662, had almost expelled them, the Portuguese having only the factories of Goa left.

The discovery of the East Indies happened in the reign of King Henry VII. who refused assistance to Columbus in the discovery of America, and so neglected the trade of the East Indies. And Henry the VIIIth and his two successors were otherwise employed. But Queen Elizabeth sent out with a fleet Sir Francis Drake in 1557. He passed the Magellanic Straits into the South Seas, and took many rich prizes from the Spaniards off the coast of Chili and Peru, and then stood over for the East Indies. He arrived at the Molucca Isles and at Java, and was kindly received; he then proceeded to the Cape of Good Hope; and after three years, he arrived with abundance of wealth in England. This was the first voyage that ever had been made round the globe by the English.

In 1586, Thomas Candish, Esquire, with a similar commission to that of Sir Francis Drake, set out on a second circum-navigation, which he performed in two years and one quarter. He annoyed the Spaniards in the South Seas, and then stood over to the Ladrones, thence to the Philippine, and to Java, and so home by the Cape of Good Hope.

In 1591, John Lancaster made a successful trading voyage to the Indies; whereupon a company was formed, and 72,000*l.* advanced for a stock to carry on a trade to that place:

K

They

Remark. 15 German miles make 60 geographical: 12 Bohemian and Sclavia, 60 do.

They obtained a charter of incorporation from the Queen, in 1600. This company sent out five ships, and carried a letter from the Queen to the King of Achin in the isle of Sumatra, and were kindly received. But the Portugueze, who were settled there, and then subject to Spain, included in our wars with that nation: They accordingly, with all their art, endeavoured to set the King against us; but he would not be led by them, having heard of our glorious victory over the Spanish Armada in 1588; so that he became our friend, and was so kind as to assist us in disappointing the Portugueze in all their plots against us. Here we took in pepper, and passed on to Bantam in Java, where we settled a good correspondence and factory; we then proceeded to the Eastward, and took a Portugueze ship in the straits of Molucca.

They returned home with good cargoes. From this time, ships were sent out annually, and endeavours used to settle trade in all parts of the Indies: But the Portugueze and Dutch, by their artifice with the natives, rendered the trade very uncertain. In the year 1612, a treaty was concluded with the Great Mogul, by which we were allowed a free trade, and to settle factories in his dominions; and in the year 1614, Sir Thomas Rowe went ambassador from King James I, to him; and our company has ever since kept factories in divers places there. In 1514, our ships sailed to Japan, where the captains made a treaty with the King, and settled a factory which lasted some time. Soon after, Madraspatan (commonly called Madras) on the coast of Coromandel, was obtained from the King of that place, with liberty to build a fort, which is called Fort St. George, and is the seat of our English sovereignty on the East side of C. Comarin, and on the West side of Surat. We have also the sovereignty of Bombay, on the coast of Cambaia: The island Angediva, near Goa: Fort St. David's, near Nagapatan, on the coast of Coromandel, which the company purchased. See Moll's Geography, p. 75. Part II.

Their factories on the coast of Africa, between the Cape and the Red Sea.

On the Coast of Malabar, at Surat, Bombay, Dabal, Goa.

In the dominions of the Great Mogul; Agra, Amadabat, Cambaya, Bradra, Baroche, Dabul, Pettapoli and Matfalipatan.

At Siam, Cambodia, Tonquin.

At Achin, Prianim, Ticon, Fort Bencoolen, and Jambe in Sumatra.

At Sacadano and Bandermafs in Borneo.

At Macasser in Celebes,

The Dutch endeavoured to find a nearer passage to India, by the North, along the coast of Norway, Lapland, Nova Zembla, and Tartary; but their attempts proved unsuccessful. In 1525, they sent out four ships under the command of Cornelius Houtman; by the Cape of Good Hope, they sailed to Madagascar, Sancta Maria, and Antongil, Sumatra, Bantam, and Tuba in Java, and to the isles of Madura and Bally, and arrived in Holland, in August, 1597. In 1598, the Dutch sent 80 ships to the East and the West Indies: And in 1602, a charter was granted to a company, who raised a fund of 600,000l. sterling, which stock in six or seven years, was augmented to near 3,000,000l. besides a yearly dividend of 30 or 40l. per cent. Thus they settled themselves in the most remarkable places of the East Indies.

On the coast of Malabar, they have Onor, Barcelor, Mangalor, Cananer, Oranganor, Cochin, Coulam. On the coast of Coromandel, Ticticorin, Negopatam, Karkalle, and Palkeacate. Also in Malacca, in Ceylon, in Bornia, and Moluccas. The Danes have a trade in the bay of Bengal, and on the coast of Pegu; but are masters only of two places on the coast of Coromandel, Krankebar and Dansburgh.

The French, in 1664, erected a company for the commerce of the East Indies, and fixed their chief residence and factory in the isle of Madagascar: They traffick much at Siam.

The empire of the Great Mogul, Indostan, or Mogulistan, is bounded by Great Tartary, on the North; Persia, on the West; the Peninsula of India and the bay of Bengal, on the South;

South; the kingdoms of Pegu, Ava and Thibet, and China, on the East. Situate between 20 and 40° North latitude, and between 70 and 90° East longitude; being more than 1200 miles square. Agra, the metropolis of this Empire, is nine miles long. Produce, Rice, for their corn of general use; garden fruits, a great many more than with us; also mangoes, almonds, cocoas, &c. The land in many places is mountainous and sandy soil, with stones, such as Jasper, Agat, granates, chrysolites, amethysts, rubies, and some diamonds. Woods, which are much more solid than ours; the bannian tree, which spreads in such a manner as to make a whole forest; for the young boughs bend downwards till they touch the earth, and there take root, and become a new tree, joined to its mother; and so on from the mother-tree every way, to an innumerable number, all conjunct, and proceeding from the mother-tree. The people there cut into the trunk of the palm and the toddy trees, and thereby they extract a juice which issues plentifully, and is a delicious drink, called tody and nery, which the common people drink instead of wine. They extract a rich spirit from rice, which they call arrack, which is drank by the better sort. Horned cattle, and sheep, buffaloes, goats, deer, Elks, Antelopes, asses, mules, dromedaries; camels and oxen are used for drawing coaches, waggons, ploughs, &c. Horses are not natives of this land, but they are brought from Persia and Arabia.

ISLANDS on the COAST of INDIA.

Maldives, are a ridge of islands about 1000 in number, and lie between 2° S. and 8° of N. lat. situate in 74° E. lon. and S.W. from C. Comorin (the Southern point of the coast of Malabar) 260 miles. — Ceylon isle lies between 6 and 9° N. lon. 80° E. and its Northernmost point, Lafanatapa, is about 1° from the coast of Coromandel. — Sumatra between 6° S. and 6° N. lat. This island on the W. and the coast of the kingdom of Malacca on the E. make the sea and straits of Malacca. — Java on the S.E. and Sumatra on the N.W. make the straits of Sunda, which is from 15 to 20 miles over.

The Produce of the Indian Islands.

1. Maldives produce cocoas and fruits. The inhabitants make garments of silk and cotton.
2. Ceylon: Rice, pepper, ginger, sugar, cardanum, tobacco, and fruit of all kinds, grows wild; the talipot tree produces leaves six to nine feet long, and are used for bed and tent by travellers; this leaf will fold up like a fan. In the rivers and sea coast are found pearl and rubies. The most valuable produce of this island, is cinnamon. The Dutch possess all the ports and havens on its coast, and engross all the produce.
3. Sumatra: Plantains, bonanas, oranges, limes, cocoas, pomgranates, mangoes, mangestans, rice, citrons, camphire, &c, poultry, cattle, wild beasts, elephants; their rivers, fish. Gold in their mountains, and pepper in their valleys, in great quantities sent to England. The first English factory was established here at Achin, and at Bencoolen, about the year 1685, which is the place where the pepper is shipped, as it grows only on the Southern part of this island.
4. Java: Rice in plenty, sugar, fruits, cattle, fowl and fish, wild beasts, pepper, but not so good as at Sumatra.
5. Borneo: Diamonds, bezoar stones, the best camphire in India, rice and pepper, cotton, honey, wax. The sea coast is possessed by the Hollanders: There are diamonds of the highest value, gums; gold dust is found in the rivers amongst the sands, and the richest bezoar stones are found in the stomach of the wild ape.
6. Port Celebes, E. of Borneo, between 1° 30' N. and 5° 30' S. lon. 140° E. There is a long narrow cape which ends in a point at its North-end, by Dampier, 30 leagues long N.E. The N.W. wind blows from November till March; their houses are built upon piles nine or ten feet high, to prevent the floods from carrying them away. Produce; rice and spices, fruit. The Dutch possess the capital on the South part of the isle. There are many other small isles: 1. Bally, 2. Lomboc, 3. Flores, 4. Tamor, which produces white sanders wood, and wax.

7. The

7. The spice islands: Produce; prodigious quantities of nutmegs and cloves. The Portuguese discovered these isles in 1511; since which the Dutch, by frequent wars, have expelled them and all other Europeans, and now have the monopoly of that trade. 1. Banda is the chief island for nutmegs and cloves. 2. Ternate, 3. Tidore, 4. Amboyna, 5. Ceram*. There are five or six other small isles.

The Molucca islands: 1. Ternate, 2. Tidore, 3. Motir, 4. Machiam, 5. Barbian. Produce; cloves, almonds, and some fruit, goats and poultry. They make bread of the pith of a tree, which they beat into meal, knead it with water, and bake into cakes, which they call sagu†; an excellent nourishing food as we experience. These islands are all governed by the Dutch, who have forts. The Molucca and spice islands also produce oranges, lemons, nitrons, sugar-canes, cocoa, potatoes, millet, tobacco, and fruits.

2. Philippine islands, discovered by Magellan, in 1521, and named so in honour of Philip II, then King of Spain, by whom they were conquered; and they are now under the Spanish government. There are about 1000 isles: The principal are; 1. Manilla, 2. Mindana, 3. Paragoa, 4. Tandaya. Produce; rice, cocoa, cattle, fowls, fish, wild beasts, and fruits of various kinds, honey, wax, gum, bezoar, &c. rich pearl, ambergrease, cotton, civet (from the cat), gold in plenty, brazil and ebony wood, and timber for ships. There are many gold mines in these islands, and the value of 200,000 pieces of eight, is gathered annually, without the help of fire or quicksilver. In the isle of Sibu, in 10° N. the famous Ferdinand Magellan, the first circum-navigator, was killed by the Indians, after the King and his chiefs had been baptized.

* The nutmeg tree is like our peach tree; the fruit is inclosed within a husk, like our walnut, within which is a leaf which incloses the shell; this leaf is the mace; and within the shell is the nutmeg: These are gathered three times a year. The clove tree is like our lawrel; its fruit grows in clusters,

† Sagu, fago, or Libby tree: It is a medicine against the flux.

ERRATA to PAGE 120.

Page 17, line 24, for 3 i. 9 l. read 3 feet and 9 lines

21 7, $19^{\circ}.00'$ W. var. of Pico

29 9, col. 8, against Havre-de-Grace, $0^{\circ}.17'$ E.
against Caen — $0^{\circ}.16'$ W.

Chichester, 3d col. $50^{\circ}.52'$ N.

30 35, by the Map of Ireland, Dublin, $53^{\circ}.12'$ N. $6^{\circ}.40'$ W.

Wexford, $52^{\circ}.13'$ N. $6^{\circ}.16'$ W.

Waterford, $51^{\circ}.07'$ N. $6^{\circ}.52'$ W.

Cork, $51^{\circ}.40'$ N. $7^{\circ}.56'$ W.

32 27, against Algiers, $2^{\circ}.18'$ E.

19 2, (Second Part) read artificial Numbers.

Line 9, for lat. $28^{\circ}.39'$, read $28^{\circ}.30'$.

Against the 1st Feb. under lat. by account, for $39'$, read $30'$.

4th ditto, under dep. $r. 73'$.

7th ditto, ditto $r. 40'$.

13th ditto, ditto $r. 60'$ and lon. in $25^{\circ}.40'$ W.

16th ditto, lon. made $0^{\circ}.33'$ E. lon. in $23^{\circ}.03'$.

17th ditto, ditto $0^{\circ}.03'$ E.

19th do. made lat. $30'$ dep. $0^{\circ}.29'$ W.

Correction + $25'$.

+ $24'$ W.

18th, lat. by obs. $2^{\circ}.27'$ N.

lon. made $0^{\circ}.53'$ W.

20th, dep. $23'$ W. lon. made $23'$ W. lat. in $1^{\circ}.01'$ N.

22d, lat. by account, $22'$ S. by obs. $0^{\circ}.22'$ S.

24th, dep. $16'$ W.

March 7, lon. made $38'$ E. | lat, by account, $21^{\circ}.58'$ S.

— Correction + $4'$ + 14

8, dep. $40'$ E. lon. made $41'$ E. lon. in $28^{\circ}.30'$ W.

Note. Folio 61 was by mistake numbered 65.

(1)

The ELEMENTS of GEOMETRY.

DEFINITIONS.*

1. **G**EOMETRY, is that science, by which we learn how to compare things extended with one another, or determine how any one thing is greater, equal to, or less extended than another.
2. In things extended are three dimensions, viz. length, breadth and thickness.
3. A point is that which has no parts or magnitude; that is, a geometrical point is not any quantity, but an assignable place in a quantity.
4. A line, is a length without breadth or thickness.
5. The ends of a (mathematical) line are points, without magnitude.
6. A right line, lies even, or in the same direction: A curve line, continually changes its direction.
7. Parallel lines, (strait or curved) are such as lie equally distant from one another, in every part; such lines, if infinitely continued, will never meet.
8. An angle, is the inclination of two lines to one another, meeting in a point, called the angular point; as at a, when formed by two right lines, it is a plane angle; if by curve lines, it is a curvilinear angle; and when form'd by circles of a sphere, it is called a spherical angle.
9. A right angle, is that which is made by one right line as AB, standing upon another line, as CD, making the angles on each side of it equal, viz. the angle ABC is equal to the angle ABD; so that the line AB does not incline more to one side than the other; then the line AB is called a perpendicular: All angles, but right ones, are called oblique angles.
10. An obtuse angle, is greater than a right angle, as the angle CBE.
11. An acute angle, is less than a right angle, as the angle DBE.
12. A surface, or superficies, is the outside of any thing, and is that magnitude which has only length and breadth: The limits of a surface are lines; except the surface be contained by a curve line, as the circle's area is contained by a curve line, which is called its circumference, or periphery.
13. A plane, is that surface which lies perfectly even between its extremes, or limits.
14. A right lined figure, is a plane figure bounded by right lines only. Every right lined figure, has as many angles, as it has sides.
15. A triangle, is a figure bounded by three lines.
16. A solid, is a magnitude contained by three dimensions, viz. length, breadth, and thickness. cor. The extremes of a solid are surfaces.
17. The square of a right line, is the space included by four right lines, each equal to it, and drawn perpendicular to one another.
18. The rectangle of two lines, is the space included by four lines, drawn perpendicular to one another, the opposite lines being equal.
19. Commensurable magnitudes, are such as may be measured by one and the same measure.
20. Incommensurable magnitudes, are such as have no common measure. As the numbers 11 and 12; 25 and 26, &c. which cannot be divided by any number without a remainder to one of them.
21. The comparison of quantities, or the relation they have to one another, is what is called Mathematics.
22. The comparison of two quantities is called their ratio; and the similitude of ratios is called proportion.
23. That quantity which has its parts united, is called magnitude, and is the subject of Geometry.
24. Mean proportionals, are all the intermediate terms between the extremes, in a geometrical progression.
25. Surds, are such numbers as have no exact roots; all numbers are surds, whose roots are not some of the natural numbers, 1. 2. 3. 4. 5. &c. ad infinitum.
- B
26. Diagonal

* By definition is to be understood, a short description of a thing by its properties.

26. Diagonal of a figure, is a line drawn across from one angle to another.
27. Area of a figure, is its superficial content; i. e. the number of square feet, yards, poles, perches, acres, &c. that are contained within the limits of the figure.
- Pl. 1. 28. Solidity of a solid, is the cubic inches, feet, &c. contained in it.
- Fig. 4. 29. A square figure has four equal sides, and its angles right; but if its opposite angles are obtuse and acute, it is a rhombus.
- d. 30. A parallelogram has its opposite sides, and opposite angles equal; and if its angles be right, it is a rectangle, or a right angled parallelogram; if its opposite angles are equal but not right angles, it is a rhomboides.
1. 31. Ratio of two quantities, is the quotient arising by dividing one quantity by the other. Terms of the ratio are the antecedent and its consequent, or the first term by the second.
2. 32. Proportional quantities are those, which have the same ratio, when compared two and two together; that is, when the first is to the second, as the third is to the fourth.
3. 33. Alternate terms, are the antecedents or the consequents of different ratios.
- c. 34. Magnitudes are of three kinds; the first kind are lines, the second are surfaces, and the third are solids. (Def. 16.)

DEFINITIONS of a CIRCLE.

6. 1. **A** Circle is a plane figure, bounded by one uniform curve line, every part of the curve being at equal distance from a point in it, called its center; the curve which bounds it, is called its circumference.

Characters and Abbreviations.

+	more, to be added, as $2 + 3$ is 5
-	less, to be subtracted, $5 - 2$ is 3
$\times$	times, to be multiplied, 3×3 is 9
$\div$	divided by, as $6 \div 3$ is 2 or $\frac{6}{3} = 2$ and $\frac{12}{4} = 3$.
=	equal to, as $8 \times 2 = 4 \times 4 = 16$.
:	is to, in ratio of two terms.
::	so is; Thus $A : B :: B : C$. or $3 : 5 :: 5 : 8\frac{1}{3}$
And	$A : B :: C : D$ or $3 : 5 :: 12 : 20$.
	parallel to, as the line A is to the line B.
N ^o .	number, sq. square.
an. or $\angle$	angle; $\angle$ $\angle$ or $\angle$'s, angles.
o, , "	degrees, minutes, seconds, as
or, d m s	20 degrees, 30 minutes, 25 seconds: Thus $20^\circ 30' 25''$.
And.	S, sine; cs, or cos, cosine.
also	t, tan, or tangent.
co-t	ct, co-tangent. Sec. Secant.
r. or	R, radius, or sine of 90° , which is the greatest of all sines.
arch, arc	a part of the circumf. of a circle.
comp.	complement, of an arc or $\angle$ to 90° , is what the given $\angle$ wants to make it 90° .
Sup.	supplement of an arc or $\angle$, is what it wants to make 180° . Thus, the $\angle A = 140^\circ$. Its supplement is 40° .
Perp.	Perpendicular.
$a^2 + b^2$	denotes the Sq. of the quantity represented by a, added to the Sq. of the quantity b, &c. of others.

2. The circumference (or periphery) of every circle, great or little, is supposed to be divided into 360 equal parts, which are called degrees; each degree into 60 equal parts, called minutes; each minute into 60 equal parts, called seconds; and so on, for thirds, fourths, &c. Whence the arch of a semicircle contains 180 degrees; the quadrant 90° , the sextant 60, and the octant 45 degrees: Also, the reflecting instruments which are called octants and sextants, are $\frac{1}{4}$ and $\frac{1}{6}$ of the circumference of the circle of which they are the radius of; and by the principles and properties of reflexion, all angles measured by them, are double the angle of the arch, and the arch or limb of the instrument is numbered accordingly.

Note, when an angle is denoted by three letters, the middle letter is that which stands at the angular point denoted by it.

3. The area of a circle (or other figure) is the quantity contained within its bounds, in square measure.
4. Angles at the center of a circle, are measured by the chords, sines, tangents, secants, and versed sines of their subtending arches.
5. Any angle or arch of a circle may be measured by the line of chords; by describing the arch of a circle, with the chord of 60° in the compasses, and one foot fixed in the angular point with the other, describe an arch so as to join the two sides or lines which make the $\angle$, and then the chord of the extent of that arch, being applied to the line of chords (on the scale) will shew the degrees contained, by the lines, or the $\angle$ made by them.

6. A chord

6. A chord, is a right line which divides the circle into two equal or unequal parts, as, EI or EH.
7. An arc or arch, is any part of the circumference, as, DE, EBH, or IAD.
8. A sector, is a part bounded by two radii, and the arch between them, as, AC, IC, and AI.
9. A segment (of a circle) is a part cut off by a right line (as EGH) which divides the circle into two parts or segments. A sine is a right line within a circle, being $\frac{1}{2}$ of the chord of double the given arch; so EG is the sine of the arch EB.
10. A tangent, is a line touching a circle, which produced, does not cut it, as BF: A secant is a line contained between the center of the circle and the extreme of the tangent, as CF.
11. Angle at the center, is that whole angular point (C). is at the center, as DCE.
12. Angle, at the circumference, is when the angular point is in the circumference, as DAC, EDA, &c.
13. Angle in a segment, as EBH. EDA. DAI.
14. Angle of, or upon a segment, as EHB which sides stand upon the arc EB.
15. Similar sectors, triangles, arches, sines, tangents, &c. are those bounded by radii of different circles, that make the same angle; as the chords Gb, BE, of the arches Gb, BE; sectors GCB, BCE; sines bd, EG; tangents GE, BF, and these parts are proportional.
16. Similar segments, are those which contain similar triangles, as the triangle bdG, EGB; and similar triangles are those, which contain equal angles; each $\angle$ of one triangle, being equal to each $\angle$ of the other triangle.
17. A figure is inscribed in a circle, or a circle circumscribed about a figure; when all the angular points of the figure are in the circumference of the circle.
18. A circle is inscribed in a figure, or a figure circumscribed about a circle; when the circle touches all the sides of the figure.
19. One figure is inscribed in another, when all the angles of the figure inscribed, are in the sides of the other.
20. In all circles, similar arches are as their diameters, or radii; that is, Ca : ab :: CD : DE.
 $\text{radi. arch. radi. arch.}$
 or, as CG : Gb :: CB : BE. And Cd : db :: CG : GE, and :: CB : BF.
21. The circumferences of circles are to one another, as their diameters, or as their radii are.
22. The angle of contact, FBE, made by the curve line EB, and the right line BF, is less than any right lined angle.
23. The triangles Cdb, CGE, CBF are similar; for their angles are equal; [def. 16.] consequently their sides are proportional. (See Theo. 15. of the Elements of Geometry.)
24. If the diameter of a circle be 1, the periphery is 3,14159 and its area is 0,7854 nearly. But if the diameter be 2, the periphery is 6,28318, &c. and its area 3,1416 nearly.

GEOMETRICAL PROBLEMS.

PROBLEM I.

TO divide (or bisect) a given right line into two equal parts. Let AB be the given line to be divided.

Set one foot of the compasses in A, open the other foot to more than half the given line, and describe an arch, as CD; with the same extent and one foot in B, make the sections in the arch CD; as at d, e; then lay a ruler to these points of section, d, e, and draw a right line which will bisect the line AB, into two equal parts in the point E.

Note, The N^o. 1, 2, &c. in the margin, denote the N^o. of the figures in the plate referred to.

PROBLEM II.

To let a perpendicular fall from a given point, upon a given right line.

Let C, be the point, and AB the line; upon the point C, describe the arch AB, and upon A and B, with equal radii, make the section D, draw CD, and the line CB, will be perpendicular to AB.

P R O-

P R O B L E M. III.

- Pl. 1. To erect a perpendicular on the middle of any given right line, or on any given point in it.
- Fig. 3. Let the given line be AB, and E, the given point in it; set off from E, equal distances, as EA, EB; and on the points A and B, make the intersection of the arches, as at C, then draw CE the perpendicular required.

P R O B L E M IV.

To erect a perpendicular upon the end of a given line, as AB.

- Take at pleasure the point C above the line AB, from that point C, with the distance CA, describe the part of a circle DAE, draw the right line DCE, then from the section at E, draw the line EA, as required.

To draw a line perpendicular to a given right line, by the given numbers, in the table under, base, perp. hyp. which numbers are the lengths of the sides of similar right angled triangles, and to be taken off from a scale of equal parts, which equal parts may represent, inches, feet, yards, fathoms, poles, furlongs, miles, leagues, &c.

Numbers.		
Base.	Perp.	Hyp.
3	4	5
6	8	10
9	12	15
12	16	20
15	20	25
18	24	30

Thus set any N^o. in the 1st. column on the given line, and then with the pencil-pen, in the compasses, take the corresponding perpendicular in inches, and with one foot of the compasses as at A, describe an arch, as at E; then take the number under hyp. in the compasses (corresponding to the base and perpendicular) and set one foot at B, the other point of the base and make the section as at E, through which the perpendicular must pass.

P R O B L E M V.

To draw a right line through a given point, parallel to a given right line.

5. Let B, be the given point, through which a line is to be drawn parallel to the line AF, upon the point B, as a center, describe the arc CDE, to touch the line AB, as at D, with the same extent of the compasses upon the point G, describe the arc HIK; draw the line PQ, through the point B, to touch the arc HIK, and it will be parallel to the given line AB.

P R O B L E M VI.

To divide a given right lined angle, into two equal angles.

6. Let the meeting of the lines AC, BC, be the angle to be bisected, upon the angular point C, with any radius as CA, describe an arch as AB, upon the points A and B, describe with the same extent two arches crossing each other, as at D, then draw the line CD, and the angle will be equally bisected.

P R O B L E M VII.

Three right lines being given, to form them into a triangle, (provided any two of them taken together be longer than the third)

Make the longest line AB, the base of the triangle.

7. Then take one of the other lines in the compasses and with one foot in A, describe an arc, and with the other line in the compasses and one foot in B, cross the former arch, as at C; then draw the lines from A and B to C, and the triangle will be finished or formed.

P R O B L E M VIII.

To divide a given right line, into any number of equal parts.

Let AB be the line proposed to be divided into ten or any number of equal parts.

8. From the points A, B, draw the lines AC, BD, parallel to each other, and at any convenient inclination to the given line, then set off from the points A, B, in the lines AC, BD, the number of equal parts, the given line is to be divided into, and such that the

the parts AG, BF, shall be greater than AB; and so, all the dividing lines to be drawn from the points in AC, to them in BE, be perpendicular to AB, or nearly so; otherwise the points of division will be badly defined, as may be easily conceived by viewing the figure.

P R O B L E M IX.

To find a mean proportional line, between two given right lines.

Let the lines A, B, be the given lines; draw an indefinite line, as AG, make AB=line A; and BD=line B; bisect AD, as in C; on C, with the radius CA=CD, describe the semi-circle AED; draw BE perpendicular to AD, to join the arch in E; then BE will be the mean proportional. Pl. I.
Fig. 9.

Illustration. Let AB=18, BD=8; and by proportion.

AB : BE :: BE : BD :: *AB × BD = BE. Squared. = 8 × 18 = 144, its Sq. root is 12 = BE.

P R O B L E M X.

To divide a given right line, into a given proportion.

Let AB be the line proposed to be divided in proportion of the lines C, D, E, F.

Upon the point or extremity A, draw at pleasure the line AC; make AH equal to the line C, HI equal to the line D, IL equal to the line E, and LD=line F; draw the line BD, and LE, IO, HG parallel to it; and the line will be divided in the points G, O, E, as required. 10.

P R O B L E M XI.

Two right lines being given, to find a third proportional.

Let the lines B, and C, be the given lines, to which it is required to find a third proportional line, both increasing and decreasing. 11.

Make at pleasure the angle DAF, and make AB equal to the line B, and AE equal to the line C; on the point A, describe the arcs BC, ED, and draw the line BE, and DF, GC parallel to it; then AF and AG will be the third proportionals sought.

In numbers.
$$\begin{array}{l} 1 \left\{ \begin{array}{l} AB : AE :: AE : (AD) : AF. = \\ 16 : 20 \text{ so is } 20 \text{ to } 25. \end{array} \right. \text{the 3d. proportional increasing.} \\ 2 \left\{ \begin{array}{l} AE : AB :: AB (=AC) : AG. \\ 20 : 16 :: 16 \text{ to } 12,8. \end{array} \right. \text{the 3d. proportional decreasing.} \end{array}$$

P R O B L E M XII.

Three right lines being given, to find a fourth proportional line, both increasing and decreasing.

Let A, B, C, be the three lines proposed, to find a fourth, which shall be to the third, as the second is to the first.

Make at pleasure the angle KDL, and make the part DE equal to the line A, and the part DF equal to the line B, and the part EG equal to the line C; draw the lines EF, GH, parallel to each other, and FH will be the fourth proportional line, as required. 12.

In numbers. Let the lines A, B and C be represented by the numbers 12, 10 and 8 respectively, then it will be

As $\left\{ \begin{array}{l} DE : DF :: EG : FH. \text{ Suppose } DF = 8 \\ 12 : 10 :: 8 : 6\frac{2}{3} :: 20 : 16\frac{2}{3} \end{array} \right. \left\{ \begin{array}{l} DE = 10 \\ DH = 12 \end{array} \right. \left\{ \begin{array}{l} \text{Then } DF : DE :: DH : DG. \\ \text{or } 8 : 10 :: 12 : 15 : \end{array} \right.$
i. e. as the sum of the 1st and 3d to the sum of 2d and 4th.

P R O B L E M XIII.

To make a square upon a given right line.

Let AB be the given line, erect the perpendicular BD=AB, then with the radius AB, on the points A and D, describe the arcs as at C; and to the intersection C, draw AC, DC, which complete the square required. 13.

C

P R O-

* Note, ∴ is to be read, Therefore.

P R O B L E M XIV.

- Pl. I. With two given right lines A and B, to make a rectangle.
 Fig. 14. Make the base $CD = B$, draw DF perpendicular to CD , and equal to the line A; with the length B, and one foot in F, describe an arch E; with the line AC, and one foot in C cross the arch at E; draw FE , EC , and $CEFD$, will be the rectangle sought.

P R O B L E M XV.

To trisect a quadrantal arch.

15. Let AB be the given arch to be trisected; set off the radius AC from A to E, and from B to D, which are the points of trisection.
 Any arch may be trisected by trial of equal extension.

P R O B L E M XVI.

To draw a tangent to a given circle, from a point given.

16. Let BDE be the circle, and A the point; C the center of the circle, draw AC , and bisect it, as in D; with the radius DA , describe a semicircle, and draw AB to join the circle at B, where the semicircle cuts it; and BA will be the tangent as required.

P R O B L E M XVII.

To measure an angle, which is made by two right lines; or to measure the inclination of two lines, in respect of each other.

17. 1. If the lines meet in a point, as the lines Aa , Ab , in the point A; on A, with the chord of 60° describe an arch, as ab , and take the chord of the arch ab , in the compasses, and its measure on the line of chords is the measure of the angle. But if the lines do not meet in a point, continue them till they do, and then measure the inclination as before: Note, if the sides of the figure be not so long as the chord of 60° , which you take from a scale of chords, you must continue such line or lines, so as to join the circular arch, as the line AB , for D is continued to b ; whence the arch aG is the measure of the $\angle aAG$; and ab , of the $\angle aAb$; and bd , of the $\angle bAD$; also the $\angle GAD$ is = the arch GD .

Let AD be a line, to which another is to be drawn from A, which shall make an angle with AG , = 110° . having described the arch, set off from D, the chord of 90° to g , and then set 20° from g to a , and draw A thro' a , and the angle will be constructed.

P R O B L E M XVIII.

In a given triangle to inscribe a circle, that shall touch all its sides, or to circumscribe a circle about a triangle.

18. Let ABC be the triangle, bisect any two of its angles (as A and B) by Problem 5. their intersection will be the center of the circle required, as the point at D: But to find the center of its circumscribing circle, bisect any two of its sides, and the point of their intersection will be the center.

P R O B L E M XIX.

To make a scale of chords (of a semicircle) continued to 180 degrees.

19. First draw a right line of any length at pleasure, as AB , and on its center C, describe a semicircle. 2. Erect the perpendicular CD , and trisect the arches AD , DB , by Problem 15. and the semicircular arch will be divided into parts of 30° each. 3. Trisect each part (by trial) and the arch of the semicircle will be divided into each 10° , which number as in the figure. 4. On the point A, with the radii's A 10 , A 20 , A 30 , &c. transfer the distances of the divisions of the arch ADB , to the chord line, or diameter AB , and number them accordingly; and it will be the line of chords as required.

In like manner, the chord of each degree and minute may be laid down in a line of a sufficient length.

P R O

P R O B L E M. XX.

Upon a given right line, to describe the segment of a circle which shall contain an angle, equal to a given angle.

Let the inclination of the lines aI , and bI , be the given $\angle$, and AB the given line. Pl. I.
Fig. 20.
Make the $\angle BAO = \angle I$, draw AG perpendicular to AO , bisect AB in D , and erect the perpendicular DE , which will intersect AG in C ; on C with the radius $CB = CA$, describe the circle $AFGB$, and draw AF , AE , BF , BE , BG , so as to meet any where in the circumference, then the $\angle OAB = \angle AFB = \angle AEB = \angle AGB$; each $\angle$ being made in the same segment of the circle AEB , as required.

DEFINITIONS of GEOMETRY.

A proposition is either a problem or a theorem.

1. A problem is something proposed to be done.
2. A theorem is something proposed to be demonstrated, and from which a general rule is deduced.
3. A lemma is some principle demonstrated, in order to shorten the demonstration of the thing under consideration.
4. A corollary is a truth obtained by the foregoing demonstration.
5. A scholium is remarks made on the foregoing.
6. Similar triangles are those whose angles of one triangle are equal to those in the other triangle, each to each respectively; that is, in the triangles ABC , abc , $\angle A = \angle a$, $\angle B = \angle b$, and $\angle C = \angle c$; and their sides, which contain the equal angles, are proportional thus, $AB : AC :: ab : ac$, and $:: Bc : bc$.

GEOMETRICAL THEOREMS.

T H E O R E M I.

A right line standing upon another right line makes angles with it, which are either two right angles; or taken together, are equal to two right angles (13. e. 1.)

D E M O N S T R A T I O N.

Let the right line DC , stand upon AB ; on C , with any radius describe the arch ADd , then the arch AD is the measure of the angle ACD ; and the arch Dd , the measure of the $\angle DCB$; but the arches $AD + Dd$ are = two right angles, being a semicircle; hence the $\angle b$, + $\angle c$ are = 180° . or two right angles. Q. E. D.

Corollary. Since the circumference of every circle contains 360° , or four right angles; therefore all the angles that can be made at any point are = 4 right angles, and all the angles that can be made on one side of a right line are = 2 right angles.

T H E O R E M II.

If two right lines intersect one another, the two opposite angles are equal. (15. e. 1.)

D E M O N S T R A T I O N.

Let AB , CD be the lines intersecting at E , by the last Theorem, the $\angle a + \angle b = 180^\circ$ and the $\angle b + \angle E = 180^\circ$. therefore $\angle a = \angle E$; and since the $\angle E + \angle c = 180^\circ$. } Take the $\angle E$ from each, and there will remain $\angle c = \angle b$ } Q. E. D.
and $\angle E + \angle b = 180^\circ$. } and $\angle a = \angle E$.

Suppose $\angle a = 79^\circ.47'$ then
the $\angle b$, will be = 100.13 . = $\angle b$
because $\angle a + \angle b = 180.00$. = $\angle b + E = \angle E + \angle c$.

T H E-

Note, 13. e. 1. denotes the Theorem is the 13 Proposition of Euclid's 1st. Book.
Q. E. D. Quod erat demonstrandum. Which was to be demonstrated.

T H E O R E M III.

If a right line intersect two parallel right lines, it will make the opposite and the alternate angles, equal to one another. (29. e. 1.)

D E M O N S T R A T I O N.

Suppose the lines AB, CD, parallel to each other, then the right line EF, makes the angles $a + d = e + b$, on the same side of the parallel lines, and the angles $d + c = b + g$; therefore the opposite angles $a = c$, and $e = g$, consequently the angle $a = e = g$, and the alternate angles $a = g$, and $d = f$, which was to be proved.

T H E O R E M IV.

The sum of the three angles of every plane triangle, is equal to two right angles. (32. e. 1.)

D E M O N S T R A T I O N.

Let ABC be the given triangle, draw the line EF parallel to AB, through the point C; then will the $\angle a = \angle g$, and $\angle b = \angle f$, by Theorem 3. But the angles $a + c + b = g + c + f$, $= 180^\circ$, or two right angles by Theorem 1. Q. E. D.

Corollary 1. If one $\angle$ of a triangle be a right $\angle$, the sum of the other two angles, will be equal to a right angle. Cor. 2. All the inward angles of any right lined figure, make twice as many right angles abating four, as the figure has sides.

T H E O R E M V.

If one side of a triangle be continued, the outward angle will be equal to the two inward, opposite angles (by 32. e. 1.)

D E M O N S T R A T I O N.

Let the side AB be continued to D (in the last fig.) Then by Theorem 1. the $\angle d + \angle f = 180^\circ =$ the angles $g + c + f$, from each sum, take the $\angle f$, and there will remain the $\angle d = \angle g + \angle c$. Q. E. D.

T H E O R E M VI.

In every plane triangle equal sides subtend (i. e. are opposite to) equal angles. And equal angles are subtended by equal sides. (5. 6. e. 1.)

Suppose the triangle ABC, to be an isosceles triangle, whose side $AC = BC$; bisect the $\angle C$, then the angles on each side of the bisecting line CD, at the point D, is a right $\angle$, therefore $\frac{1}{2} \angle C$, $(ACD) + \angle A = 90^\circ$.

and $\frac{1}{2} \angle C$, $(BCD) + \angle B = 90^\circ$.

But $\frac{1}{2} \angle C + A = \frac{1}{2} \angle C + B \therefore \angle A = B$. Q. E. D.

T H E O R E M VII.

In every plane triangle the longest side subtends the greatest angle. And the greatest angle subtends the longest side (18. e. 1.) This is evident by the figure, and therefore needs no Demonstration; for if AD be made $= AC$, and CD drawn; then the $\angle BDC = \angle A + ACD$, and $\angle ADC = ACD$, is greater than $\angle B$. And $\angle C$ is greater than $\angle A$, for BE is $= BC$, therefore the $\angle C$ is greater than $\angle A$, as before.

T H E O R E M VIII.

If the sides of two triangles be equal, the angles opposite to those sides, are also equal (5. e. 1.)

D E M O N S T R A T I O N.

This is evident by Theorem 6. in which figure the triangle ACD is = triangle BCD, and AC is = CB; also AD is = BD, and DC common to both triangles, $\therefore$ the $\angle A = \angle B$, $\angle ACD = \angle BCD$, $\angle ADC = \angle BDC$. Q. E. D.

T H E O R E M IX.

An angle at the center of a circle is double to the angle at the circumference, when both the angles stand upon the same arch. (20. e. 3.)

D E M O N S T R A T I O N.

Let AE be the diameter, C the center; then the $\angle FCE$ is the $\angle$ at the center. But by Theorem 5, the $\angle FCE = \angle A + \angle F$; because AC = CF, $\angle A = \angle F$, by Theorem 6.

Hence $\angle FCE = 2 \angle A$, or the double of the $\angle FAE$. Also the $\angle ECD = 2 \angle EAD$, and $\angle FCD = 2 \angle FAD$. Q. E. D. Fig. 7.

Corollary 1. All angles at the periphery, which stand on the same segment, or arch of a circle, or upon equal arches, are equal to one another. (26. 27. e. 3.)

Corollary 2. Angles that stand on equal circumferences, in the same or in equal circles, are equal to each other, whether they be at their centers or circumferences.

The $\angle ADB = \angle AEB = \angle AFB$, each standing on the same arch AB; also because AF, BE, are diameters; therefore the $\angle ECF = \angle ACB$, standing upon equal arches AB, FE. Fig. 8.

Corollary 3. An angle in the circumference, and standing on the arch of a semicircle, is a right angle.

T H E O R E M X.

An angle in a semicircle is a right angle; that is, if the diameter of a circle be the side of a triangle, and the $\angle$ opposite to that side be any where in the circle's periphery, it is a right angle. (31. e. 3.)

D E M O N S T R A T I O N.

Let AB, DE, be diameters, C the center; then $\angle DCB = 2 \angle A$, and $= \angle A = \angle ADC$, and $\angle B = \angle BDC$, because equal sides subtend equal angles, (by Theorem 6.) But Fig. 9. $\angle ADB = \angle CDA + \angle CDB = \angle A + \angle B$; consequently $\angle ADB = 90^\circ$, a right $\angle$. Otherwise thus: because $\angle ADC = \frac{1}{2} \angle ACE$, and $\angle BDC = \frac{1}{2} \angle BCE$, therefore $\angle ADC + \angle BDC = (\angle ADB)$ Theo. 1. $= \frac{1}{2} \angle ACE + \frac{1}{2} \angle BCE = \frac{1}{2}$ two right angles = one right angle. Q. E. D.

Cor. An angle made in a segment that is greater than a semicircle, is less than a right angle; and an $\angle$ made in a segment that is less than a semicircle, is greater than a right angle.

T H E O R E M XI.

The (straight line) right line drawn at right angles to the diameter of a circle, from the extremity of it, is without the circle; and no right line can be drawn between that right line and the circumference from the extremity, so as not to cut the circle. (16. e. 3.)

D E M O N S T R A T I O N.

Let HGD be a circle, the center of which is C, and the radius CD; the right line DE, drawn at right angles to CD, from the extremity D, is wholly without the circle. Fig. 11.

- Remarks.
1. Any two sides of a triangle is greater than a third.
 2. That $\therefore$ denotes therefore, and is so to be read.
 3. That 2 has a greater ratio to 3 than it has to 4; but 4 has a greater ratio to 2 than 3 has to 2. See 8. e. 5.

D

For

For if it does not, let the chord DB represent it; and because $CD = CB$, the $\angle D = \angle B$; but the $\angle D$ is a right angle; $\therefore \angle B$ is a right angle, and the angles D and B are
 *17. e. 1. = two right angles; which is impossible *. (Theorem 4.) Therefore the right line drawn from D, at right angles to CD, is without the circle.

Corollary 1. From this it is manifest that there can be but one straight line which touches the circle in the same point.

Corollary 2. If a right line touches a circle, the line drawn from the center to the point of contact, shall be perpendicular to the line touching the circle.

Corollary 3. If a right line touches a circle, and from the point of contact a right line
 19. e. 3. be drawn at right angles to the touching line, the center of the circle shall be in that line.

T H E O R E M XII.

In all circles, similar lines and arches are as their radii; and the lines which contain the equal angles are proportionals.

D E M O N S T R A T I O N.

4, 5, 6, 7, Let the circles HDG, *bdg* be both described on the center C; draw the radii CD, CB,
 8, 9. e. 6. and continue CB to F: Also draw the tangent lines *adf*, ADF, and then the arches *db*,
 Fig. 11. DB, and the tangents of these arches *df*, DF, will be similar, having the angle C common
 Def. 8. 10. to both the triangles, and the sectors of the circles. Therefore $Cd : db :: CD : DB$.
 15. of a And $Cd : df :: CD : DF$. Also $Cb : Cf :: CB : CF$. And $Cf : CF :: fd : FD$.
 circle. (By 12. e. 6.)
 Prob. 12.

T H E O R E M XIII.

In a circle, the angle made at the point of contact between the tangent and any chord, is equal to the angle in the alternate segment. $\angle ECF = \angle EBC$, and $\angle ECA = \angle EGC$.

D E M O N S T R A T I O N.

Fig. 13. From the point of contact C, draw COD, which is perpendicular to AF. (Theorem 9.
 • Theo. 10. Cor. 3.) The angle CED is a right angle *; therefore $\angle D + \angle ECD = \text{a right } \angle = \angle DCE$.
 + $\angle ECF$. Therefore the angle $D = \angle EBC = \angle ECF$. And $\angle CEG + \angle G = \angle GCF + \angle ECA$;
 but $\angle GEC = \angle GCF$. $\therefore \angle G = \angle ECA$.

Corollary 1. A tangent to the middle point of an arch is parallel to the chord of it.
 32. e. 3. For if the arch $CB = \text{arch } CE$, then the chord $CB = \text{chord } CE$; whence $\angle E = \angle B = \angle ECF$,
 and BE, CF are parallel.

T H E O R E M XIV.

Prob. 12. If four right lines be proportionals, the rectangle contained by the extremes is equal to the rectangle contained by the two means (or middle terms); and if the rectangles contained by the two means be equal to the rectangle contained by the extremes, the four right lines are proportionals. (16. e. 6.)

T H E O R E M XV.

Prob. 11. If three right lines be proportionals, the rectangle contained by the extremes is equal to the square of the mean, and the contrary. (17. e. 6.)

T H E O R E M XVI.

Upon a given right line to describe a rectilineal figure, similar and similarly situated
 Theo. 10. to a given rectilineal figure. (18. e. 6.)

T H E O R E M

T H E O R E M XVII.

Similar triangles are to one another in the duplicate ratio of their homologous sides. (19. e. 6.)

For the demonstrations of these four Theorems, see Euclid's Elements.

T H E O R E M XVIII.

In any right angled triangle, a perpendicular being drawn from the right angle to the hypotenuse (or side subtending the right angle) it will divide the triangle into two right angled triangles, similar to the first triangle and to each other. (8. e. 6.)

Note, Similar triangles are those, where each single angle of one triangle is equal to each single angle of the other triangle. (4. e. 6.)

Def. 16.

D E M O N S T R A T I O N.

Let BAC be a right angled triangle, and AD perpendicular to BC; the $\angle BAD = \angle C$, Fig. 15. for $\angle B + \angle C = 90^\circ = \angle B + \angle BAD$. Also $\angle CAD = \angle B$. $\therefore \angle C + \angle CAD = \angle B + \angle BAD$. Consequently the triangles ADC, ADB, and ABC, are alike, or similar to each other, and their sides proportionals *. Thus the sides which contain equal angles are proportional. * 16. e. 6. $AC : CD :: AB : AD :: CB : CA$. $12 : 7,2 :: 16 : 9,6 :: 20 : 12$. But $18 : 12$ is a less ratio.

Alternately. $12 : 16 :: 7,2 : 9,6$. And $5 \times 12 : 5 \times 16 :: 7,2 : 9,6$. (By 15. & 16. e. 5.)

Compoundedly. $28 : 16,8 :: 12 : 7,2 :: 16 : 9,6$. And $7,2 : 12 :: 16,8 : 28$. (By 17. & 18. e. 5.)

Corollary. If two triangles have their sides proportionals, their angles are equal.

Also in the triangles ADB, ABC, the $\angle B$ is common to both; and the $\angle D$ and $\angle C$ are right angles; therefore the remaining $\angle BAD, \angle BCA$ are equal; consequently the triangles ABD, ABC are similar. Fig. 15.

Again, in the triangles ACD, and ACB, the $\angle C$ is common, and $\angle D = \angle BAC$; therefore the triangles ABC, and ACD are similar; consequently the triangles ABD, and ACD are similar. In numbers. Let $BC = 20$, $BA = 16$, and $BD = 12, 8$; then the following proportions will be *:

Corollary 1. The rectangle of the hypotenuse and either segment is equal to the square of the adjoining side.

For $BD : BA :: BA : BC$, } and $\{ CD : CA :: CA : CB. \}$ Whence

* $12,8 : 16 :: 16 : 20$ } and $\{ 7,2 : 12 :: 12 : 20. \}$

$BD \times BC = BA$ squared, and $CD \times BC = CA$ squared.

Corollary 2. The rectangle of the hypotenuse and perpendicular is equal to the rectangle of the other two sides

$\{ \text{For } BC : BA :: AC : AD \} \therefore BC \times AD = AC \times AB$.
 $\{ \text{i.e. } 20 : 16 :: 12 : 9,6. \}$

Corollary 3. The perpendicular is a mean proportional between the segments of the hypotenuse.

For $BD : DA :: DA : DC$ } $\therefore DB \times DC = DA$ squared.
 $12,8 : 9,6 :: 9,6 : 7,2$ }

Corollary 4. The segments of the hypotenuse are as the squares of the adjoining sides.

Corollary 5. As the perpendicular : hypotenuse :: the rectangle of the segments : the rectangle of the other sides.

Corollary 6. The distance of the right $\angle$ from the middle of the hypotenuse is equal to half the hypotenuse, viz. $Ad = \frac{1}{2} BC = Bd = dC$.

T H E O R E M

T H E O R E M XIX.

If two right lines within a circle cut one another, the rectangle contained by the segments of one of them, is equal to the rectangle contained by the segments of the other. (35. e. 3.)

Let AB, CD, be the lines which intersect in the point E; then $AE \times EB = DE \times EC$.

D E M O N S T R A T I O N.

Fig. 10. Draw the lines AD, BC, and the triangle ADE will be like the triangle BEC: For the
Def. 23. $\angle A = \angle C$, and $\angle D = \angle B$, standing upon the same arches, (see Theorem 11.) and the
 $\angle AED = \angle BEC$ (by Theorem 2.) Therefore $AE : DE :: EC : EB$. $\therefore AE \times EB =$
† 16. e. 6. $DE \times EC$ †.

T H E O R E M XX.

If from any point without a circle two right lines be drawn, one of which cuts the circle, and the other touches it, the rectangle contained by the whole line which cuts the circle, and the part of it without the circle, shall be equal to the square of the line which touches it.

D E M O N S T R A T I O N.

Let E be a point without the circle, and EA, EF, and EG, right lines drawn from it; draw the lines AD, BG; then $AE \times BE = EF^2 = GE \times DE$. The angle EFC is a right
Fig. 12. angle. Also $\angle A = \angle G$, and $\angle B = \angle D$; but the $\angle E$ is common to both the triangles
* 18. e. 3. AED, and GBE. Whence $AE : ED :: GE : EB$. $\therefore AE \times EB = DE \times GE$.

Let E be the point without the circle, C the center; EG, EF the lines, of which
Fig. 12. EDG cuts the circle, and EF touches it in the point F; the rectangle EG, ED is equal to
the square of EF.

Dem. Draw Cg perpendicular to GD, then $gG = gD$, and $CF = CD$: and because the
right line GD is bisected in g, and produced to E, the rectangle GE, DE, together with
† 6. e. 2. the square of gD, is equal † to the square of gE. To each of these equals add the square
of Cg; then the rectangle $GE \times DE + Dg^2 + Cg^2 = Eg^2 + Cg^2$. But the square of
 $CE = Eg^2 + Cg^2$; because CgE is a right angle, and the square of $CD = Cg^2 + Dg^2$.
Therefore $GE \times DE + CD^2 = CE^2$; also $CD = CF$. $\therefore GE \times DE + CF^2 = EC^2$. But
 $CF^2 + EF^2 = EC^2$, because the angle F is a right angle. Therefore $GE \times DE + CF^2 = EF^2$
+ CF^2 , take away the common square from each, and there remains $GE \times DE = EF^2$: that
is, the square of CF being taken from these equals, the remaining rectangle GE, DE,
is equal to the square of FE. Q. E. D.

T H E O R E M XXI.

In any right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides. (47. e. 1.)

D E M O N S T R A T I O N.

Let ABC be a right angled triangle, BC the hypotenuse; upon which make the square
Fig. 16. BEGC, and draw AF parallel to GC.

Then by similar triangles. $BC : BA :: BA : BD$ } $CB : CA :: CA : CD$.
Whence $AB^2 = BD \times BC$ } Hence $AC^2 = CD \times CB$.

That is, the square of AB is equal to the rectangle, or product of BD, and BC, which is
the rectangle BDFE. And the square of AC is equal to the rectangle DCGF, by Corol-
lary 1. Theorem 18. But the rectangle BF + CF is = the square EC; therefore CE, or
the square of BC is = the sum of the squares of AB and AC. Q. E. D.

The

The foregoing principles may be commodiously expressed by the following equation:
 $\overline{AB}^2 + \overline{AC}^2 = \overline{BC}^2$. From which equation are deduced the two following equations, viz.

$$(1.) \overline{AB}^2 = \overline{BC}^2 - \overline{AC}^2 \therefore \overline{AB} = \sqrt{\overline{BC}^2 - \overline{AC}^2}$$

$$(2.) \overline{AC}^2 = \overline{BC}^2 - \overline{AB}^2 \therefore \overline{AC} = \sqrt{\overline{BC}^2 - \overline{AB}^2}$$

Fig. 16.

That is, the square root of the difference between the square of the hypotenuse and that of one of the other sides is the length of the third side.

Note 1. By equation is to be understood the quantity or quantities that are on each side the mark (=) which quantities are equal.

Illustration. Suppose $AC=3$, and $AB=4$, then $AC^2 + AB^2 = 9 + 16 = 25$. and the $\sqrt{25} = 5 = BC$. Also $BC^2 - AC^2 = 25 - 9 = 16$, whose square root is $4 = AB$.

Also $5 : 4 :: 4 : 3,2 = BD$, $\therefore DC = 1,8$.

And $5 : 4 :: 3 : 2,4 = AD$.

Suppose $AB=27$, and the other sides in the ratio of 3 and 5. Then $\sqrt{25-9}=4$ the third side of the similar triangle, to that whose side is 27; and $4 : 3 :: 27 : 20\frac{1}{4}$, also $4 : 5 :: 27 : 33\frac{3}{4}$, and the like of any other.

2. The square of a right line is the space or quantity included by four right lines equal to it, drawn perpendicular to one another.

3. The rectangle of two lines is the space included by four right lines equal to them, drawn parallel and perpendicular to one another.

THEOREM XXII.

The two sides of any right angled plane triangle being given, the other side is also given, by Theorem 21.

Dem. Let the diameter $AH=2$, and the chord of $60^\circ = HE = HC = 1$, the rad. of the circle; then the chord of $120^\circ = AE = \sqrt{AH^2 - HE^2} = \sqrt{4-1} = \sqrt{3} = 1,7320508$, the half of which is the sine of $60^\circ = ED = 0,8660254$. Fig. 17.

Also the chord of 60° , being $=1$, its half $HO = GF = 0,5000000$; which is the sine of 30° . And $\sqrt{1-GF^2} = \sqrt{1-\frac{1}{4}} = \sqrt{\frac{3}{4}} = 0,8660254 = CF$, the cosine of 30° which is the sine of $60^\circ = ED$, as above.

The sine and cosine of an arc being given, to find its tangent and co-tangent. Thus, as the cosine is to the sine, so is the rad. to the tangent.

Let the tangent of the arc HG , of 30° be required.

Then it will be, as $CF : FG :: CH : HI$. Hence;

As $0,8660254 : 0,5 :: 1 : 0,5773503 = HI$, the tangent of $30^\circ = BL$.

Now it will be, as the tangent is to the rad. so is the rad. to the co-tangent.

$\therefore BL : BC :: CH : HK$, as $0,5773503 : 1 :: 1 : 1,7320508 = HK$, the co-tangent.

To find the secant of the arc HG .

As $CF : CG :: CH : CI = 1,1547005$ the secant $= CL$.

To find the co-secant CK .

As $CD : CE :: CH : CK = 2,0000000$ the co-secant.

Whence it appears,

1. That the tangent is a 4th proportional to the cosine, the sine and radius.
2. That the co-tangent is a 3d proportional to the tangent and the radius, and a 4th proportional to the sine, cosine and radius.
3. That the secant is a 3d proportional to the cosine and radius.
4. That the co-secant is a 3d proportional to the sine and the radius.
5. That the rectangle of the tangent and co-tangent is equal to the square of the radius; therefore the tangent of half a right $\angle$ is the radius.

Also the co-tangents of any two different arches are to one another as the tangents of the same arches inversely.

The chord of 60° is $=$ rad. For since the triangle CEH is equilateral, the other two sides are each equal to radius, and their opposite angles are also equal, and each $= 60^\circ$, therefore the chord $HE =$ rad. $CE = CH$.

E

To

To find the fines, tangents and secants to each degree and minute of the quadrantal arc; also to find the logarithms of numbers, see Simpson's Trigonometry, [Printed for J. Nourse in the Strand, Price 1s. 6d.] where the nature and investigation of logarithms, fines, tangents, &c. are fully handled. See also Sherwin's Tables of Logarithms, or Keil's Euclid.

T H E O R E M XXIII.

If a right line be divided into any two parts, the square of the whole line will be equal to the squares of both the parts, together with a double rectangle under the same parts. (4. e. 2.)

Fig. 18. Dem. Let AB be the given line, divided in C. The square of AB is AGIB; which, according to Euclid, let be expressed by AI.

And the square of BC by IE, and of AC^2 by AE; for $AD=AC=BF$, and $BC=EH=HI$. Also BI is perpendicular to AB, and parallel to AG.

Hence GE, EB are the two rectangles, and = each other. Whence the figure ABIG, is = the figures BE + EG + AE + EI. Th. $AB^2 = AC^2 + BC^2 + 2AC \times BC$. Q. E. D.

Corollary. Hence the square of any line is = four times the square of half that line.

In numbers. Let $AB=10$, $AC=4$; then $10^2 = 100 = AB^2$.

And $6 \times 6 + 4 \times 4 + 2 \times 4 \times 6 = 36 + 16 + 48 = 100 = BC^2 + AC^2 + 2AC \times BC$.

In like manner may be demonstrated, that the difference of the squares of any two unequal right lines is equal to the rectangle under the sum and difference of those lines.

In numbers. $6 \times 6 = 36$. Also $6 + 4 = 10$
And $4 \times 4 = 16$. And $6 - 4 = 2$ } their sum and difference.

And the difference of the squares $= 20 = 10 \times 2$, the rectangle of the sum and difference.

T H E O R E M XXIV.

In any obtuse angled plane triangle, the square of the side subtending the obtuse $\angle$ is greater than the squares of the other two sides, by a double rectangle made of one of the sides; and the part of that side continued till it meets with the perpendicular let fall from the other extreme of the longest side. (By 12. e. 2.)

Fig. 19. Let ABC be the triangle proposed, and CP the perpendicular. Then $AC^2 = AP^2 + PC^2$; but $AP = AB + BP$. $\therefore AP^2 = AB^2 + BP^2 + 2AB \times BP$. By Theorem 23. And $PC^2 = BC^2 - BP^2$. By Theorem 21.

Hence $AC^2 = AB^2 + BC^2 + 2AB \times BP$. Q. E. D.

T H E O R E M XXV.

The square which circumscribes a circle, is double to the square inscribed in it.

Fig. 20. Dem. Let AEBD be the circle; the chord lines, AE, AD, BE, BD, will be the sides of the inscribed square; and FGHI, of the circumscribed square. i. e. FG, GH, HI, IF.

The diagonal AE divides the square AFEC into two equal parts; therefore the triangle AEB = $\frac{1}{2}$ the rectangle AFGB, and ADB = $\frac{1}{2}$ AIHB; consequently the square AEBD = $\frac{1}{2}$ FGHI: therefore the circumscribed square is double to the inscribed square.

Corollary 1. In every circle, the chord of 90° . is the side of the inscribed square:

And if the diameter be 1, then $AC = \frac{1}{2}$, and $AE = \sqrt{2AC^2} = \sqrt{2 \times \frac{1}{4}} = \sqrt{\frac{1}{2}} = \frac{1}{\sqrt{2}} = .707106781$.

Whence by similar triangles,

As 1 : .7071 :: any circle's diameter to the side of its inscribed square.

Corollary 2. The diameter of a circle is equal to the side of its circumscribed square.

Corollary 3. The square root of the area of that circle whose diameter is 1, viz. of .765398, is .886 the side of the square of equal area to that of the circle.

Of

OF ARITHMETICAL PROGRESSION.

WHEN any rank or series of numbers do either increase or decrease by an equal interval or common difference, those numbers are said to be in arithmetical progression.

Thus $\begin{cases} 1. 2. 3. 4. 5. 6. 7. \&c. \text{ increasing by } 1. \\ 1. 3. 5. 7. 9. 11. 13. \&c. \text{ ditto by } 2. \\ 21. 18. 15. 12. 9. 6. 3. \&c. \text{ decreasing by } 3. \end{cases}$

Lemma 1. If any three numbers be in arithmetical progression, the sum of the two extremes will be equal to the double of the mean, or middle term.

In the above series $15 + 9 = 12 + 12$. And $3 + 21 = 12 + 12$.

Lemma 2. If any four numbers are in arithmetical progression, the sum of the two extremes will be equal to the sum of the two means. $3. 5. 7. 9.$ or $1. 7. 13. 19$.

Thus $3 + 9 = 5 + 7 = 12$. And $1 + 19 = 7 + 13 = 20$.

Corollary. If ever so many numbers be in arithmetical progression, the sum of the extremes will be equal to the sum of any two means that are equally distant from the extremes.

Thus $3. 6. 9. 12. 15. 18$; $3 + 18 = 6 + 15 = 9 + 12$.

Lemma 3. Every series of numbers in arithmetical progression, is composed of the interval or common difference, so often repeated, as there are terms in the progression, except the first.

Proposition 1. In any series of numbers in arithmetical progression, the two extremes and the number of terms being given; to find the sum of all the terms. **Rule.**

Multiply the sum of the extremes by the number of terms, and divide the product by 2, the quotient will be the sum of all the series.

Ex. 1. To find the number of strokes a clock strikes in one revolution of the hand, or in 12 hours.

The first term is 1, and the last 12, the sum 13 of the extremes.

The number of the terms is - - - 12 the hours.

$2)156(78$ the number of strokes required.

Ex. 2. Suppose 100 stones placed in a line, exact a yard asunder; how many miles must he go that gathers up that number, one by one, into a basket, which is placed at a yard from the first stone.

In the solving of this question, observe that the first term is 2, and the last 200; for the man being at the basket, must go a yard to the first stone to take it up, and a yard back to put it into the basket, and the like of all the rest. Hence

$2 + 200 = 202$ the sum of the extremes, which multiply
by 50 the $\frac{1}{2}$ of the number of terms,

The answer is 10100 yards, which is 5 miles and 1300 yards, that he must walk to gather the stones, or 5M. 5F. 36P. 2Yds.

Ex. 3. Suppose a debt to be discharged by weekly payments, the first payment to be 10s. the second 15s. the third 20s. and so on to the end of 52 weeks; what is the whole debt to be discharged?

To find the last payment. $5 \times 51 + 10 = 265s. = 13l. 5s.$ the last payment:

To find the sum of all the payments. $10 + 265 \times \frac{52}{2} = 275 \times 26 = 7150s.$

The whole debt is - - - - - £. 357 : 10

To divide a N^o. into two parts in a given ratio.

General method. As the sum of the terms of the ratio, is to either of the terms of that ratio, so is the given number, to the part of it of the same kind as that of the ratio.

Ex. To divide 100 into two numbers in the ratio of 3 to 4. As $7 : 3 :: 100 : 42\frac{2}{7}$ anf.

Hence the greater part will be $57\frac{1}{7}$

Note. When numbers are compared by their excesses, it is called **Arithmetical**; but compared according to their ratios, **Geometrical**.

A R I T H -

ARITHMETICAL THEOREMS.

LET a , be the first term, e the common difference, y the last term of the series, n the number of terms, and s the sum of all the terms.

Then $a \cdot a+e \cdot a+2e \cdot a+3e \cdot \&c.$ are the succeeding terms. From whence we have $a + e \times n - 1$
 Or $a \cdot a-e \cdot a-2e \cdot a-3e \cdot \&c.$
 $= a + ne - e = y$ (Theo. 1.) $= \frac{2s-na}{n} = y$. And $a+y \times \frac{n}{2} = s$. (Theo. 2.) $= \frac{a+y}{2} \times n = s = \frac{na+ny}{2}$. If the series begin with a , then $\frac{ny}{2} = s$. Also $\frac{y-a}{n-1} = e$. is Theo. 3. And $\frac{y+a-e}{e} = n = \frac{y-a}{e} + 1$. is Theo. 4. Also $n = \frac{2s}{a+y} = \frac{y-a+e}{e}$ is Theo. 5. Likewise $a = \frac{2s}{n} - y = y + e - ne$ is Theorem 6.

SERIES, with Theorems for their Summation.

1. Series $1+1+1$, &c. or $2+2+2$, &c. or $3+3+3$, to n terms, then $an=s$.
2. $1+2+3+4+5+$ to n , terms. Theo. 7. $\frac{a+y \times n}{2} = \frac{n^2+n}{2} = \frac{n^2+y}{2} = s$. Let $n=100$, then $s=5050$.
 Note, In this series the last term $y=n$, the number of terms.
3. $1+3+5+7+9+11$, &c. to n , terms. Theo. 8. $n^2=s$. Let $n=100$, then $s=10000$. Thus $1+2+3$, &c. to n , terms; and of $1+2+3$, &c. to $n-1$, terms.
4. $1+4+7+10+13$, &c. to n , terms. Theo. 9. $n^2 + \frac{n-1 \times n}{2} = s$. Let $n=100$, then $n^2=10000$, and $\frac{n-1 \times n}{2} = \frac{99 \times 100}{2} = 4950$. the sum is $=s=14950$.
 This series is composed of the third to n , terms; and of the second to $n-1$, terms.
5. $1+5+9+13+17+21$, &c. to n , terms. Theo. 10. $n^2 + \frac{n-1 \times n}{2} = s$. (which in this) is $=66$.

GEOMETRICAL PROGRESSION.

WHEN a series of numbers increafes by a common multiplier, or decreases by a common divisor, those numbers are said to be in geometrical proportion continued.

As $1 \cdot 2 \cdot 4 \cdot 8 \cdot 16 \cdot 32 \cdot 64 \cdot 128 \cdot 256 \cdot 512$, &c.

$3 \cdot 9 \cdot 27 \cdot 81 \cdot 243 \cdot 729$, &c. here 3 is the common multiplier.

$64 \cdot 32 \cdot 16 \cdot 8 \cdot 4 \cdot 2 \cdot 1$, here 2 is the common divisor.

Def. 1. The former quantity is called the antecedent, and the following quantity the consequent. As in these $2 : 4 :: 4 : 8$. Here 2 is the antecedent, and 4 is the consequent terms of the first ratio.

And 4 is the antecedent, and 8 its consequent, in the second ratio. Also $2 : 4 :: 8 : 16$, and $2 : 3 :: 10 : 15$; and universally as any antecedent is to its consequent, so is any other antecedent to its consequent.

The ratio of 2 to 4 is the same as 8 to 16, which is 1 to 2. But the ratio of 2 to 3 is $\frac{2}{3} = 1\frac{1}{3}$, or 1 to $1\frac{1}{3}$. And the ratio of 24 to 20 is $1\frac{1}{5}$ to 1, or 6 to 5.

Lemma 1. If three numbers are proportionals, the rectangle, or product of the two extremes, is equal to the square of the mean, or middle term. Thus $2 \times 8 = 4 \times 4$.

Lemma 2. If four numbers be proportionals, the product of the two extremes is equal to the product of the two means: For $2 : 3 :: 12 : 18$, and $2 \times 18 = 3 \times 12 = 36$.

Corollary 1. If the product of any two numbers be equal to the product of any other two numbers, those four numbers are proportionals.

To find the method of summation of other various kinds of Series, see Simpson's Algebra. p. 181, Emerson's, Landen's Lucubrations, Stirling's Differentials, &c.

Whence

Whence it is easy to conceive, that if ever so many numbers are in continued proportion, the product of the two extremes will be equal to the product of any two means, that are equally distant from the extremes.

In every series of continued proportionals, that number which is compared to another, is called the antecedent of the ratio, and that number to which it is compared, is called its consequent; consequently all the terms of numbers, but the first and last, are both antecedents and consequents; that is, all but the last are antecedents, and all but the first are consequents.

As in these $2 : 6 :: 6 : 18$, here 2 is the antecedent, and 6 its consequent; and 6 the middle term is antecedent to 18 its consequent. Whence it appears, that in every series of continued proportionals, all the middle terms between the first and last are both antecedents and consequents.

Also all the terms except the last are antecedents; and all the terms except the first are consequents.

Lemma 3. If ever so many numbers are proportionals, it will be, as any antecedent is to its consequent, so will the sum of all the antecedents be to the sum of all the consequents. [By the 12. of Euc. 5th Book.]

When the consequent term exceeds its antecedent, then any consequent, divided by its antecedent, gives the ratio of the terms to each other increasing. Thus $3 : 4$ is $\frac{4}{3} = 1\frac{1}{3} :: 1$ to $1\frac{1}{3}$.

But when the antecedent exceeds its consequent, then any antecedent divided by its consequent gives the ratio of the terms decreasing. Thus 5 to 4 is $\frac{5}{4} = 1\frac{1}{4} :: 1\frac{1}{4}$ to 1 the ratio.

To find the Sum of a Series of Geometrical Proportionals.

T H E O R E M I.

Multiply the last term by the ratio, from the product subtract the first term; divide the remainder by the ratio lessened by 1, and the quotient will be the sum of all the series.

But if the first term, the common ratio, and the number of terms be only given; then to find the last term.

T H E O R E M II.

Multiply the ratio raised to the power of the number of the terms lessened by 1, by the first term, and the product is the last term.

Ex. 1. Let 3 be the first term, 2 the ratio, and 6 the number of terms; then $6 - 1 = 5$, and $2 \times 2 \times 2 \times 2 \times 2 = 32$ the ratio raised to the 5th power.

3 the first term.

Product $\frac{96}{3}$ the last term.

Ex. 2. To find the Sum of the 6 terms, 3, 6, 12, 24, 48, 96.

By Theo. I. $96 \times 2 = 192$

$- 3$

$2 - 1 = 1$ 189 (189 the sum of all the terms.)

In a long series of proportionals, to find the last term by the foregoing method is very tedious; therefore it will be proper to shew how to obtain the last term, or any other term, without producing all the terms.

In order to which it will be necessary to premise the similitude between numbers in arithmetical progression, and those in geometrical.

If to any series of numbers in continued proportion, whose first term is 1, there be assigned a series of numbers in arithmetic progression, beginning with a cypher, and the common difference 1, which are called indices or exponents.

Thus $\begin{cases} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7, \text{ indices.} \\ 1 & 2 & 4 & 8 & 16 & 32 & 64 & 128, \text{ geometrical progression.} \end{cases}$

But if the series do not begin with 1, then put 1 over the first term of the geometrical series, &c. as follows:

Series.	{	Arith.	1	2	3	4	5	6	7	8	9, &c.
		Geom.	3	6	12	24	48	96	192	384	768, &c.
		Geom.	3	9	27	81	243	729, &c.			

The addition (or subtraction) of any two indices will correspond with the product (or quotient) of their respective terms in the geometrical series, when the first, or second term, is the same as the ratio of the terms. But in the series 3 . 6 . 12 . 24, &c. where the first term is 3, and the ratio of the terms 2, in this series the indices must begin with 0, and then the sum of any two indices will correspond with the product of the respective terms, divided by the first term.

$$\text{Thus } \left\{ \begin{array}{l} 0 . 1 . 2 . 3 . 4 . 5 \\ 3 . 6 . 12 . 24 . 48 . 96, \&c. \\ 5 . 10 . 20 . 40 . 80 . 160 \end{array} \right\} \text{ And } \left\{ \begin{array}{l} 2 + 3 = 5 \text{ indice.} \\ \frac{12 \times 24}{3} = 96, \text{ the fifth term.} \\ \frac{20 \times 40}{5} = 4 \times 40 = 160, \&c. \text{ of any other.} \end{array} \right.$$

Ex. 3. Let the Series be 2 : 3, whose ratio is 1,5; and let the sum of the first 7 terms be required. Thus $2 . 3 . 4.5 . 6.75 . 10.125 . 15.1875 . 22.78125 . 34.171875$; first, to find the 7th term by having the first four terms given. Indices $3 + 4 = 7$. Correspondents $10.125 \times 6.75 = 68.34375$, which divided by the first term (2) gives the 7th term = 34,171875. And by Theo. 1. $1\frac{1}{2} \times 34.171875 = 51.2578125$
2, the first term.

$$1,5 - 1 = .5) 49.2578125 (98.515625 \text{ the sum required.}$$

GEOMETRICAL THEOREMS and SERIES.

LET a , the first term; r , the ratio of the terms; n , the number of terms; x , the last term; and s , the sum of all the series of terms.

By the foregoing principles are deduced the following Theorems.

$$\text{As } a : ra :: s - x : s - a. \therefore x = s - \frac{s - a}{r} + \frac{a}{r}.$$

Theo. 1. $ar^{n-1} = x$. When the first term is 0, or 1, then $r^{n-1} = x$ the last term.

Theo. 2. $r = \frac{s-a}{s-x}$. Let 3 . 6 . 12 . 24 . 48 . 96 . be the Series. Where $a=3$; $r=2$; $n=6$. To

find x and s . Thus, $r^n \times a = 32 \times 3 = 96 = x$. And $rx - a = 96 \times 2 - 3 = 189 = s$.

Theo. 3. $a = s + rx - rs$.

Theo. 4. $x = s - \frac{s}{r} \times \frac{a}{r} = a \times r^{n-1}$.

Theo. 5. $s = \frac{rx - a}{r - 1} = \frac{ar^n - a}{r - 1} = \frac{ar^{n-1} \times r - a}{r - 1} = \frac{ar^{n-1} \times ar - aa}{ar - a}$.

Let 1 . 3 . 9 . 27 . 81 . 243, be the Series, to find x and s .

Then $1 \times 3^5 = 243 = x$. And $\frac{3 \times 243 - 1}{2} = 364 = s$.

In decreasing Geometrical Series, call the first term the last; and the last the first: Then the above General Theorems will give the solutions.

Note. From Theo. 1. may be deduced the following

Theo. 6. $a = \frac{x}{r^{n-1}}$. And since $r^{n-1} = \frac{x}{a}$. $\therefore$ Theo. 7. $r = \frac{x}{a}^{\frac{1}{n-1}}$; also because $r^{n-1} = \frac{x}{a}$ per first.

$\therefore$ Theo. 8. $n = \frac{1. x - 1. a}{1. r} + 1 = \frac{L. x - a}{L. r} + 1$, where L , or l , denotes the logarithm.

And $1. r^{n-1} \div n - 1 = r$. Thus $1. r^{6-1} = l. \text{ of } 243 = 2,3856 +$.

$$\begin{array}{r} n-1=5) \\ r=3=0,47712. \end{array}$$

$$\text{Also } \frac{1. r^{n-1}}{1. r} = n - 1 = \frac{2,3856}{0,47712} = 5. \therefore 5 + 1 = 6 = n$$

See Sherwin's Logarithms, p. 13, 14, 15.

OF LOGARITHMS.

LOGARITHMS are artificial numbers, which numbers are disposed into tables, and placed against their natural numbers, in their natural order, from 1 to 10000, in most of the Books of Navigation; in Sherwin's and Gardiner's Tables, from 1 to 100999; and in Dodson's Anti-logarithmic Tables to 12 places. The first column contains the number, and the second its corresponding logarithm. In the above mentioned Books the method of the construction of logarithms is delineated. Also in Simpson's Trigonometry.

Note. That num. denotes number; log. logarithm; logs. logarithms. The nature of logarithms are such, that the sum of any two logarithms corresponds with the product of their natural numbers; that is, the sum of any two logarithms stands against that number which is the product of those numbers, answering to the two given logarithms.

Thus the logarithm of - - - - - 1 is 0,000000

Ditto of - - - - - 2 = 0,301030

Ditto of - - - - - 3 = 0,477121

The logarithm of 2×2 is the log. of 4, which is = 0,602060

The log. of 10—log. of 2, is the log. of - - - 5 = 0,698970

The log. of 2 + log. of 3, is the log. of - - - 6 = 0,778151

The log. of 7 is found by the method that the numbers 2 and 3 were found by; and all prime numbers have their logs. obtained by the same method. (See the following page.)

By which the log. of - - - - - 7 = 0,845098

The log. of 2 + log. of 4 is the log. of - - - 8 = 0,903090

The log. of 3 + log. of 3 is the log. of - - - 9 = 0,954242

The log. of - - - - - 10 = 1,000000

100 = 2,000000

1000 = 3,000000

10000 = 4,000000

By this construction of logarithms the index of all numbers from unity to 10 is 0; from 10 to 100 is 1; from 100 to 1000 is 2; and from 1000 to 10000 is 3, and so on.

The log. of 2 being - 0,301030

The log. of 4 will be - 0,602060

The log. of 8 will be - 0,903090

The log. of 16 will be - 1,204120

The log. of 32 will be - 1,505150

The log. of 64 will be - 1,806180

The log. of 128 will be - 2,107210

The log. of 256 will be - 2,408240

The log. of 512 will be - 2,709270

The log. of 1024 will be 3,010300

The log. of 2048 will be 3,311330

The log. of 3 being - 0,477121

The log. of 9 will be - 0,954242

The log. of 27 will be - 1,431363

The log. of 81 will be - 1,908484

The log. of 243 will be - 2,385605

The log. 5 being - - - 0,698970

The log. of 25 will be - 1,397940

The log. of 125 will be - 2,096910

The log. of 625 will be - 2,795880

The log. of 3125 will be 3,494850

The log. of 15625 will be 4,193820

&c. of the following numbers.

The CONSTRUCTION of LOGARITHMS.

BY Simpson's Trigonometry, p. 45. also by the Appendix to Cunn's Euclid, p. 376, and following pages, where the hyperbolic log. of 10 is 2,302585093, &c. And its reciprocal

$\frac{1}{2,30258509} = ,43429448$, which is the subtangent of the curve expressing the common logarithms, from the double of ,43429448, which is ,86858896: The logarithms of all the prime numbers may be obtained, as follows:

1. To

1. To the number whose logarithm is required, add its next less number, and reserve the sum.
2. Divide 0,86858896 by the reserved sum.
3. Divide the quotient by the square of the sum; and so on dividing the quotients by the square of the sum so long as division can be made.
4. Write the several quotients under each other, in their natural order, and divide those quotients by the odd numbers 1, 3, 5, 7, 9, 11, &c. respectively: Write these quotients in order under each other, and their sum will be a logarithm; to which add the log. of the next less number, and the sum will be the log. of the number sought.

Ex. 1. To find the log. of the number 2. Now $2 + 1$ is 3 the sum.

3	0,86858896	The quotients.
9	0,28952965	÷ 1. is ,28952965
9	0,03216996	÷ 3. is ,01072332
9	0,00357444	÷ 5. is ,00071489
9	0,00039716	÷ 7. is ,00005674
9	0,00004413	÷ 9. is ,00000490
9	0,00000490	÷ 11. is ,00000044
9	0,00000054	÷ 13. is ,00000004
9	 9	÷ 15. is , 0

The sum is the log. of 2 = 0,30102998, because the log. of 1 is 0,00000000.

Ex. 2. To find the log. of 3. Now $3 + 2$ is 5 the reserved sum. The square of the sum is 25.

5	0,86858896	The quotients.
25	0,17371779	1) is = 0,17371779
25	0,00694871	3) is 0,00231624
25	0,00027795	5) is 0,00005559
25	0,000011118	7) is 0,00000159
25	0,000000445	9) is 0,00000005
25	0,000000018	11) is 0,00000000

To this log. - - - 0,17609126

Add the log. of - 2 0,30102998

The sum is the log. of 3 0,47712124 And the like for the logs. of all prime num.

The Nature and Use of the TABLE of LOGARITHMS.

THE first figure of a log. or that on the left hand of the point, is called the index, or characteristic; which, if it be affirmative, always shews how many places of integers the number has in it; and the index is always one less than the number of places of whole numbers. If the index be negative, it denotes what place of decimals the first figure of the number stands in; so the index always shews the distance of the first figure from the place of units.

Thus

Numbers.	Logarithms.
Thus the log. of 1507 is	3,178113
1006	3,002598
100	2,000000
1000	3,000000
9009	3,954677
901,8	2,955110
90,18	1,955110
7,05	0,848189
5,3	0,724276
0,75	-1,875061
0,08	-2,903090

If the index be 0, { It shews there is to be one of the places a whole number.
 If it be - - - 1 { two places } whole numbers.
 If - - - - 2 { three places }
 If - - - - 3 { four places }
 If - - - - 4 { there will be five places of figures to be whole numbers, and so on.

The logarithm of any number that does not exceed four places of figures is found at sight in the Books of Navigation, in the Table; and in Sherwin's Table of Logarithms, to five places; but if the number of places exceed four*, the proportional part of the log. must be found. As for Ex. suppose the log. of 54037 be required. Find the log. of the first four figures, with a cypher in the place of the other figure, viz.

The log. of 54030 is 4,732635

Ditto of 54040 is 4,732715

Diff. of numbers 10 of logs. 80

Now say, as 10 : 80 :: 7 : 56, to the log. 4,732635

Add the proportional part - - - - - 56

The log. of 54037 is - - - - - 4,732691

To find the Logarithm of a Number that consists of 5, 6 or 7 Places of Figures.

Find the log. of the first four places with cyphers, to which log. prefix its index; and find the log. of the next greater number, and their difference; then by the Rule of Three say, as the difference of the numbers is to the difference of the logs. so is the residue of the figures of the first number to the parts of the log. corresponding.

Ex. Let it be required to find the log. of 597698.

The log. of 597600 is 5,7764106

Ditto of 597700 is 5,7764833

Difference 100 and 727

Now to the log. - - - 5,7764106

Add the proportional part 712

The log. required - - - 5,7764818

As 100 : 727 :: 98 : 712

$$\begin{array}{r} 98 \\ \underline{5816} \\ 6543 \\ \underline{712,46} \end{array}$$

A Logarithm being given, to find the corresponding Number.

Find the log. or the nearest thereto, in the column of logarithms, and against it in the column of numbers is the n°. thereof; and its index will shew how many places of integers the number consists of. Suppose the given log. be 3,174861, the n°. is 1408. If the log. be 0,9097699, the n°. is 8,124. If the log. be -1,796488, the n°. is ,6259. If the log. be -2,796488, the n°. is ,06259, &c. of any other.

To multiply Numbers together by Logarithms.

Find the logs. of the given numbers, which set under each other; then add them together, and find the n°. corresponding to the sum, which is the product of the numbers.

Ex. Multiply 97 = 1,986772

by 79 = 1,897627

Product 2663 = 3,884399

Multiply 7663 = 3,884399

by ,06 = -2,778151

Product 459,8 = 2,662550

* By the common tables.

G

Multiply

Multiply 7014 and 67,58 and ,007946 together.

Log. of 7014 is 3,945966
 of 67,58 is 1,829818
 of ,007946 is -3,900148

Product $3766,46 = 3,575932$

To divide one Number by another.

Subtract the log. of the divisor from that of the dividend, find the n°. answering to the remainder, and it will be the quotient, which is the answer.

Ex. Divide 968,7 by 5,17. The log. of 968,7 is 2,986189

Ditto of 5,17 is 0,713490

The quotient $187,4 = 2,272699$

To find the Square and Cube of Numbers, and to extract Roots.

What is the square of 27,8, and what the cube of 9,017?

The log. of 27,8 is	- - - - 1,444045	Log. of 9,017 is	- - - - 0,955062
Index of the power mult. by	- - - - 2	Index of the power mult. by	- - - - 3
Its square	- - - - $772,8 = 2,888090$	Its cube	- - - - $733,1 = 2,865186$

What is the square root of 2, and what is the cube root of 3?

The log. of 2 is	- 0,301030	Log. of 3 is	0,477121
Divide it by 2 the index	} 0,150515 = 1,414 + the root	Div. by 3 is	0,159040 = 1,443 - the root
of the root, and it gives			

Of the TABLE of SINES and TANGENTS.

THIS table contains the logarithmic sines and tangents of every degree and minute of the quadrant.

Note, The sine or tangent of any arc or angle, which is less than 90° , is also the sine or tangent of the supplement of that arc or angle to a semicircle, or 180° . Some tables contain sines, tangents, and secants of arches; but as the secants are readily obtained from the sines; for which, and their little use in practice, they are omitted in many books: For the secant of an arc is the complement of the cosine of that arc to 20.

Let it be required to find the sine, cosine, tangent, co-tangent, secant and co-secant of $81^\circ . 39'$. and of $129^\circ . 47'$.

Arc of $31^\circ . 39'$	} its sine is - 9,995372 cosine - 9,162025 secant - 10,837975 co-secant 10,004628 tangent 10,833346 co-tangent 9,166654	Arc of $129^\circ . 47'$	} its sine - 9,885627 cos. - 9,806163 sec. - 10,193897 co-sec. 10,114373 tan. - 9,911724 co-tan. 10,083276
or of $98^\circ . 21'$		or of $50^\circ . 13'$	

To find readily the Complement Arithmetical of a Logarithm.

The complement-arithmetical of a logarithm, is the residue of that logarithm to 10,00000 or 20,000000,* as the complement arithmetical of 9,9198464 is 0,0801536; for if you subtract 9,9198464 from 10,0000000, the remainder is 0,0801536 the complement arithmetical. But a readier way is to take the residue or remainder of the first figure to 9, and so of the rest until you come to the last figure, which take from 10, beginning at the left hand; thus to take the complement arithmetical of 9,9198464.

From 9,9999990

Take 9,9198464

Remains 0,0801536 the complement arithmetical.

* Note, The sum of the logs. of the tan. and co-tan. of any arc is = 20. ∴ When the index of a tan. is 20, or more, subtract it from 20.

To find the Complement Arithmetical of the Logarithm of a Number, Sine, Tangent, or Secant.

This may be done by writing down what each figure wants of 9, beginning at the left hand, and what the last figure wants of 10; otherwise the co-ar. or complement arithmetical of a sine is the co-secant; the radius 10 being deducted, and the co-ar. of a co-sine is the secant thereof lessened by 10. The co-ar. of a tangent is its co-tangent; and of a co-tangent, its tangent. The co-ar. of a secant or a co-secant is what it wants of 20.

of the co-ar. of the sine of $40^\circ . 40'$ is 0,1859808
 of the co-sine - - of $40^\circ . 40'$ is 0,1200366
 of the tangent - - of $40^\circ . 40'$ is 10,0659441
 of the co-tangent - of $40^\circ . 40'$ is 9,9340559
 of the secant - - of $40^\circ . 40'$ is 9,8799634
 of the co-secant - of $40^\circ . 40'$ is 9,8140192

To find the Natural and Logarithmic Sine, Cosine, Tangent and Co-tangent of any Arch or Angle.

Let 10000000000 be the natural radius of the table of sines, whose index is 10, and its log. 10,000000, for the sine of 90° , which is the greatest of all sines; consequently the index of the sines of all angles, both greater and less than 90° , will be less than 10, because the next or nearest number less than the radius, will have one place in n° . less than the radius; therefore its index will be 9.

Thus $\frac{1}{2}$ the radius is 5000 000 000 Index 9, log. and ,698970 the log. sine of 30° .

Natural sine of $60^\circ = 8660 254 000$ will be 9,937518 the log. sine of 60° .

Natural tan. of $30^\circ = 5773,503 000$ will be 9,761439 the log. tan. of 30° .

Natural tan. of $60^\circ = 17320 508,000$ will be 10,238549 the log. tan. of 60° .

Natural tan. of $75^\circ = 37320 588 000$ will be 10,5719475 the log. tan. of 75° .

Natural tan. of $85^\circ = 114300 520 000$ will be 11,0580482 the log. tan. of 85° .

Note, The sine or tangent of any arch or angle which is less than 90° , is also the sine and tangent of its supplemental arch, to 180° .

Hence the sine of $0^\circ . 30'$ is also the s. of $179^\circ . 30'$; and of the $1^\circ . . 00'$ is the s. of 179° ; and the s. of 1° and minutes to 2° , in the table, may be annexed to 178° and 181° ; as the sine of 1° and the minutes, approaching from 1° to 2° , have their sines increasing; and the sines of increasing arches in the second and fourth quadrants decrease, as they increase in the first and third from $0'$ to $90'$, and decrease from 90° to 180° , where the sine becomes 0. In the third quadrant they increase from 180° to 270° , and at the beginning of the 4th they begin to decrease, and so continue to 0, where they began.

Note, The logarithms of the natural numbers are taken from the table of logarithms, and applied to the index of sines and tangents as above.

The corresponding Sines and Tangents of the Degrees of the Arches of a Circle,

Arches.	Degrees.	Nat. Sine.	Log. Sine.
0° 180°	180° 360°	0,000000	0,0000000
1 179	181 359	0,174524	8,2418553
10 170	190 350	1,736482	9,2396702
20 160	200 340	3,420261	9,5340517
30 150	210 330	5,000000	9,6989700
40 140	220 320	6,427876	9,8080675
50 130	230 310	7,660444	9,8842540
60 120	240 300	8,660254	9,9375306
70 110	250 290	9,396926	9,9729858
80 100	260 280	9,848078	9,9933515
90 90	270 270	10,000000	10,0000000

Note, The 1st and 4th columns contain the numbers which are the supplement to each other; and the like of those in the 2d and 3d columns.

The

The natural fines of the degrees and minutes being obtained, the logarithms of those natural fines are the log. fines as in the table of fines; and the log. tangents are the logs. of the natural tangents, &c. of secants and versed fines. Hence if the log. fine or tangent be given, the natural number of its log. is its natural fine, tangent, &c.

In Sherwin's Tables of Logarithms there are the natural and artificial fines, tangents, secants and versed fines, to each degree and minute of the quadrantal arch.

PLANE TRIGONOMETRY.

1. **PLANE TRIGONOMETRY** is the art of finding the sides or the angles of plane triangles, by having given any three parts of the triangle (except the three angles.)

2. A plane triangle is made by three right lines, which are called its sides; and if one side be perpendicular to another, or make a right angle with it, then it is called a right angled triangle; but if it have no right angle, it is called an oblique triangle.

3. The circumference of every circle contains four right angles; and each right angle is subtended and measured by an arch of 90° ; an acute angle by an arch which is less than 90° ; and an obtuse angle by an arch which is greater than 90° . See def. 2. of a circle, in p. 2. of Geometry.

4. In a right angled triangle, the side opposite to the right angle is called the hypotenuse, and the other two the legs, or sides, or the base and perpendicular; and the base is that side on which the triangle is supposed to stand.

5. In all plane triangles, the sum of the three angles contain 180° , or two right angles.

6. Every triangle has six parts, three sides and three angles; and the sides are denoted or estimated by measures of length, as feet, yards, fathoms, poles, furlongs, miles, &c. The angles are estimated by circular measure, in degrees, minutes, seconds; and for adoption of these circular measures of angles, there are computed, and put into tables, the lengths of certain right lines of a circle, such as fines, tangents, secants, versed fines, &c. to each degree and minute of the quadrantal arch; and in Gardiner's Log. Table, to each ten seconds of a minute; by which lines of the table is formed a triangle similar to every triangle (whose sides are given) that can be proposed.

The names of the different lines and parts in and of a circle, are defined in p. 2 and 3. of the foregoing Elements of Geometry.

T H E O R E M I.

In every right angled plane triangle, any one of the three sides being made radius, and a circle described from one end of it as a center, the other two sides will be, or represent fines, tangents, and secants of their respective angles: Then it will be, as any one side is to what it represents in the table *, so is any other side to what it represents in the table (of log. fines and tangents).

In the triangle ABC, right angled at B, on the point A describe the arches BE, CD. Then if AC be the radius, AB is the fine of the $\angle C$, and BC is the fine of the $\angle A$.

If AB be the radius, BC is the tangent of the $\angle A$, and AC its secant.

And because the fines, tangents and secants of the angles these sides represent, may be found in the tables *, and that they form a triangle similar to the given triangle. Whence $\text{rad} : AC :: s, \angle A : BC$, and $:: s, \angle C : AB$.

Also, $\text{rad} : AB :: t, \angle A : BC$, $:: \text{sec. } \angle A : AC$.

T H E O R E M II.

The sides of every plane triangle are proportional to the fines of their opposite angles.

In the triangle ACB, on AB, and on AC continued, let fall the perpendiculars CD, BE; then (by Theo. 1.) $AC : CD :: R : s, \angle A$.

And $CD : CB :: s, \angle B : R$.

Note, $s, \angle A$ denotes the fine of the angle A; $t, \angle C$ the tangent of the angle C; R. or rad. for radius.

* Tables of Logarithms.

Therefore

Therefore by composition and division we get $AC : CB :: s, B : s, A$, which were to be demonstrated.

Again, $AB : BE :: R : s, A$.

And $BE : BC :: s, C : R$. Whence, as before, we get

$AB : BC :: s, C : s, A$. Q. E. D.

Two Sides, and the contained Angle being given, to find the other angles.

THEOREM III.

As the sum of any two sides, is to their difference, so is the tangent of half the sum of their opposite angles, to the tangent of half their difference.

Let ABC be the triangle; AC , BC the sides opposite to the angles required; make Fig. 23. $CD = CB$, draw BD , and draw BF and DE perpendicular to it. Then $AF = AC + CB$ the sum of the sides, and $AD = AC - CB$ the diff. of the sides.

Dem. Because the $\angle CBD$ is = the $\angle CDB$, having equal sides (Theo. 8.) and the $\angle A + ABC = \angle CBD + CDB$, those having the $\angle C$, their common supplement to 180° , or two right angles. Whence the $\angle DBC$ is $= \frac{1}{2}$ the sum of the angles opposite to AC , BC . Also, the $\angle ACB$ is the difference of the angles A and ABC ; for the $\angle B$ is a right $\angle$; and the $\angle C$ is double to the $\angle ABD$, both standing on the same arch BD ; (See Theo. 9.) therefore the $\angle ABD$ is $\frac{1}{2}$ the difference of the $\angle A$ and B . And because DE is parallel to BF , it will be as $AF : AD :: BF : DE$. But the $\angle ABC$ and BDE are right angles; therefore BF , DE are tangents of the $\angle BDF$ and DBE to the radius BD . Q. E. D.

Note, Instead of the tangent of $\frac{1}{2}$ the sum of the opposite angles, you may take the co-tangent of $\frac{1}{2}$ the included angle, which is equal to it.

The three sides of a triangle being given, to find the angles.

THEOREM IV.

In any triangle, if a perpendicular be let fall upon the greatest side, it will be, as the base or greatest side, is to the sum of the other two sides, so is the difference of these two sides, to the difference of the segments of the base. And the sum of $\frac{1}{2}$ the base, and $\frac{1}{2}$ the difference of the segments, is the greater segment; and the diff. of the $\frac{1}{2}$ sum and the $\frac{1}{2}$ difference of the segments is the lesser segment.

Lemma. The sum and difference of two quantities being given, to find the quantities.

Let x be the greater, and y the lesser of the quantities whose sum is $= s$, and diff. $= d$.

$$\text{Then } x + y = s$$

$$\text{And } x - y = d$$

$$2x = s + d, \text{ and } x = \frac{s + d}{2}.$$

$$2y = s - d, \text{ and } y = \frac{s - d}{2}.$$

Whence $\frac{1}{2}$ the sum added to $\frac{1}{2}$ the diff. is = the greater quantity or number and $\frac{1}{2}$ the diff. taken from half the sum, is = the lesser quantity or number.

Dem. In the triangle ABC , the base or longest side is AB , the sum of the other two sides Fig. 24. is $AG = AC + CB$, the diff. of AC , CB is AH , the segments of the base are AE , EB ; their difference is AF , (By Theo. 15.) $AB \times AF = AG \times AH$. Therefore $AB : AG :: AH : AF$; that is, the base, is to the sum of the sides, as the difference of the sides, to the difference of the segments of the base. For $EB = EF$, and AF is the difference of the segments. Q. E. D.

Let AD be $= DB$, then $\frac{1}{2} AF = DE$, which is $\frac{1}{2}$ the difference of the segments.

Now $AD + DE = AE$, the greater segment; and $DB - DE = EB$, the lesser segment. Consequently, to get the segments of a side, add and subtract the $\frac{1}{2}$ diff. of the segments to and from $\frac{1}{2}$ the length of the side; the sum will be the greater, and the difference will be the lesser segment.

ELEMENTS of PLANE TRIGONOMETRY.

Fig. 1, 2, 3. **I**N right angled plane triangles, any side being made radius, or semidiameter of the circle, the other two will be sines, tangents, or secants, as in the figures 1, 2, 3, of Trigonometry.

ARTICLES and RULES to be observed in forming PROPORTIONS.

1. In any right angled plane triangle, if two angles and a side be given, then the angle opposite to the given side must be the first term; the given side the second term; the angle opposite to the side required the third term; and the side required will be the fourth term.

2. If an angle be required, then the side opposite to the given angle will be the first term; the given angle the second; the other given side the third term; the angle opposite to it will be the fourth term. This method of comparison is called the direct method of comparing opposites. Thus * when an angle is required, begin the proportion with a side, which is opposite to a given angle; but when a side is required, begin with an angle, which is opposite to a given side.

3. When two sides are given, and the angles required, the unknown side cannot be made radius; but when the angles are known, and a side, all the three sides may be made radius, as will appear by the following proportions. Note, that the sides of triangles have the same ratio * to each other, as the sines of their opposite angles; and consequently the first and second terms may be sides, or angles; then their opposites will be the third and fourth terms.

4. When the base and perpendicular are given, to find an angle; say, as the base is to the perpendicular, so is the tangent of 45° ($=R=10$), to the tangent of the angle which is opposite to the base; which angle is commonly called the vertical angle.

5. Always compare the side made radius, with the radius of the tables, (that is with the s. of 90° , or the t. of 45° ; which is always 10.) or compare the rad. to the side made radius.

6. To find the fourth term. From the sum of the logarithms of the second and third terms, take the logarithm of the first, the remainder will be the logarithm of the fourth term; if the fourth term be a side, find in the logs. of numbers, the nearest log. to that of the fourth term, and against it in the column of numbers will be the number sought. But when the fourth term is an angle, find in the logarithms of angles, the degrees and minutes which correspond nearest to the log. of the fourth term. See the examples below.

Fig. A.

In the triangle ABC, are given $AC=50$; $AB=40$, and $\angle B=90^\circ$.

To find the $\angle C$, by Trigonometry.

1st. term, As $AC\ 50 = 1,69897$

2d. : s, $\angle B\ 90^\circ = 10,00000$

3d. :: $AB\ 40 = 1,60206$

4th.: s, $\angle C\ 53^\circ.08' = 9,90309$

The comp. of $\angle C$ is $\angle A\ 36^\circ.52'$

To find BC, begin the Proportion with an $\angle$.

As sine of $\angle B\ 90^\circ = 10,00000$

: $AC\ 50 = 1,69897$

:: s, of $\angle A\ 36^\circ.52' = 9,77812$

: $BC\ 30 = 1,47709$

Note, If the complement arithmetical of the log. of the first term be taken, then add it to the logs. of the second and third terms, and the sum will be the log. of the 4th term.

Ex. From 9,999910

Take 1,69897

8,30103

2d term 10

3d do. 1,60206

s. of $53^\circ.08' = 9,90309$ the log. of the 4th term,

In this subtraction, begin at the left hand figure, and take each from 9, till you come to the last figure, which take from 10.

Otherwise,

Otherwise, the complement arithmetical may be taken out at sight for angles;
 The co-ar. of the sine of an angle is its co-secant—radius (10.)
 And the co-ar. of the cosine of an angle is its secant—radius (10.)
 Also the co-ar. of the tan. of an angle is its co-tangent; and of the co-t. is the tangent.

The CONSTRUCTION of the PLANE SCALE,

DRAW a line, as AB; and on its middle C, draw the perpendicular CF, and BE parallel Fig. 25.
 to it. Draw the chords AD, BD; divide the arch BD into nine equal parts (by Prob. 8.
 and 15.) and the arch AD into eight, by continual bisection (as by Prob. 1.); then with
 one point of the compasses in B, transfer the several divisions from the arch to the chord,
 which number in like manner with those of the arch. Also on A, as a center, transfer the
 divisions of the arch AD to the chord, and number them. Draw right lines from the center
 C, through each division of the arch BD, till they meet with the line BE; which divisions of
 BE number as the arch is numbered. On the center C, transfer the divisions from the tangent
 line BE, to the line CF of secants, which number accordingly. Draw DG parallel and equal
 to AC, and divide it into six equal parts (by Prob. 8.); draw GA, and lines parallel to it,
 from the divisions 1, 2, 3, &c. to touch the circumference, and mark the points; then on
 D transfer them to the chord AD, and number the points of division 10, 20, 30, 40, 50,
 60, for the lines of longitude.

Draw lines from the divisions of the arch BD, parallel to DC, and number the points of
 division of CB, 10, 20, &c. to 90, for a line of lines of arcs reckoned from the point D,
 towards B. A ruler applied to the point A, and the several divisions of the arch BD, will
 give the points of the division of the line CD of half tangents: Whence in the figure is
 obtained the natural lines of one side of the plane scale, viz.

AD, a line of rhumbs and longitudes.

BD, a line of chords.

CB, a line of sines.

BE, a line of tangents.

CF, a line of secants.

CD, a line of semi-tangents.

Together with lines of equal parts are all the lines that are usually put on one side of the
 plane scales.

On the other side of the scale are put the artificial lines of sines, tangents, secants, versed
 sines, and of numbers. Also a line of equal parts and of meridional parts; which lines
 are the logarithms of the natural numbers, and these are called Gunter's lines, from the
 inventor, viz.

1. The uppermost line is a line of artificial sines of the rhumbs; they are marked S. R.
 or S. Rhumbs, and numbered 1, 2, 3, &c. to 8, which signifies the eight points of the
 compass, and they are reckoned from the meridian to the East or West points of the horizon;
 this will plainly appear by the figure of the thirty-two points or winds of the compass. In Fig. 26.
 this line each point is divided into half and quarter points.

2. The next line is the line of the tangents of the rhumbs, marked T. R. and numbered
 1, 2, 3, 4, towards the right hand, and 5, 6, 7, towards the left; because the tangent of four
 points is equal the tangent of 45° , or radius.

Note, that each point contains $11^\circ \frac{1}{4} = 11^\circ 15'$. and eight points are equal to 90° .

Remark. That the half of every diameter of a circle is a radius, which radius is the sine of 90 degrees,
 and it is the greatest of all sines that can be drawn within a circle; therefore each radius of a circle is the
 sine of 90 degrees; consequently when we call a right angle the radius, we mean the sine of 90 degrees.

Hence, as the radius, or sine of 90 degrees is to the hypotenuse, so is the sine of another angle to the
 length of its opposite side.

Note. All sines are lines within a circle, and tangents are lines without the circle; and secants are part
 within and part without.

3. The

3. The next line is the line of numbers of a double radius, marked *Num.* and it is numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10, at the end of the first radius, where the second radius begins; which is numbered in like manner, to 10, at the end of the 2d radius.

4, 5, 6. The lines following those are the line of sines, of versed sines, and of tangents; which are marked *Sin.* for sines; *V. S.* for versed sines; and *tan.* for tangents. This is the last of the logarithmic lines.

The next is a line of meridional parts, marked *Mer.* And the following is generally a line, or lines of equal parts, and marked *E. P.*

The particular use of those lines will be shewn in the following work.

To resolve all the Cases in TRIGONOMETRY and NAVIGATION, by GUNTER'S SCALE.

THE numbers are to be taken off from the line of numbers; the sines from the line of sines; the tangents from the line of tangents, &c.

GENERAL RULE.

Set one foot of the compasses in the first term of the proportion, and extend the other foot to one of the middle terms (that is, to the 2d or 3d term); which extent will reach from the other term to the 4th term as required. Reckon backward from 90 for cosines.

N. B. That both extents must be made from lesser to greater, or from greater to lesser numbers or degrees.

Also, that the radius of a circle is the sine of 90° , the tangent of 45° , which is equal to eight points on the sines, or four points on the tangents of the rhumbs.

If you are extending from any given angle on the tangents, and the extent reaches beyond the line or end of the graduation, you must set it as far backward as it reaches over; or thus, set one foot on 45° , or four points, and note where the other foot falls; then extend from that place to the given angle, and that extent will reach from 45° , or 4 points, to the 4th term, as required.

When in the given proportion one term is a sine, and another a tangent, then reduce one of the terms to a sine or tangent, by taking its corresponding division on the scale in its line right across, and you will have the place and the number required.

PLANE TRIGONOMETRY.

CASE I.

THE hypotenuse, and the angle at the base being given, to find the base and perpendicular.

In the triangle ABC, right angled at B, are given $AC = 340$ yards, $\angle A = 34^\circ \cdot 34'$. Required, AB and BC.

To construct the Figure.

The best method is to draw the lines with a black lead pencil, and after that with ink: the scale of inches is a proper scale for the number 340 to be laid down from, on the paper.

Plate II.
Fig. 4.

1. Draw a right line, for the base of the figure as AB, (with the pencil) of a sufficient length, which suppose to be two inches.

*Prob. 17.

2. With the chord of 60° *, and one foot of the compasses on one end of the base, as at A, describe an arch *de*.

3. Take off the line of chords the given angle A $34^\circ \cdot 34'$, and set it from *d* to *e*, where make a section. (Prob. 2.)

4 Draw

4. Draw a line from the point A, through the section e, and make $AC = 340$, taking it from any scale of equal parts.

5. From C, let fall the perpendicular CB, which will cut the base line, in the other end of the base B, and the triangle is formed.

Solution. By construction, AB measured on the same scale will be found to be 280, and BC 192,9 yards.

By Logarithms. The angle at the base being known, the angle C at the perpendicular is also known; for the sum of the acute angles of every right angled triangle, is equal to a right angle. (By Theo. 4. of the Elements of Trigonometry, p. 8.)

Hence from $90^\circ . 00'$

Take the $\angle A$ $34^\circ . 34'$

Remains $\angle C = 55^\circ . 26'$

To find BC, by Trigonometry. (Theo. 1 and 2.)

As Radius - - 10,000000
: AC 340 - 2,531479
:: sine $\angle A$ $34^\circ . 34'$ 9,753862
: BC 192,9 - 2,285341

To find AB.

As $R = s, 90^\circ$ - 10,
: AC 340 - 2,531479
:: $s, \angle C$ $55^\circ . 26'$ 9,915679
: AB 280 - 2,447158

By Gunter's Log. Scale.

1. Extend from sine 90° to $s, 34^\circ . 34'$, that extent will reach from 340 to 193 on the line of numbers.

2. Extend from $s, 90$ to $s, 55^\circ . 26'$, that extent will reach from 340 to 280 on the numbers.

C A S E II. and III.

The hypotenuse and perpendicular being given, to find the angles is Case II. to find the base is Case III.

In the triangle ABC are given, AC 340, BC 192,9, and $\angle B = 90^\circ$. Required the angles Fig. 5. A and C, and the base AB.

To construct the Figure.

1. Draw a base line of a sufficient length.
2. On one extreme of the line as at B, erect the perpendicular $BC = 192,9$.
3. Take 340 in the compasses (from the same line of equal parts that BC was taken from) and set one foot in C, with the other foot make the section in the base, at A, and draw AC, AB, and the triangle is formed.

Solution. By construction, $\angle A$ measures $34^\circ . 30'$. Therefore the $\angle C$ must be $55^\circ . 30'$, which is nearly true.

And the side AB measures 280 of the same denomination, as AC, BC, whether feet, yards, poles, furlongs, miles, &c. as by Art. 6. of the Elements of Trigonometry.

By Logarithms.

To find $\angle A$. (Theo. 2.)

As AC 340 2,531479
: Radius - - 10,000000
:: BC 192,9 2,285341 (by Case 1.)
: $s, \angle A$ $34^\circ . 34' = 9,753862$
:: $\angle C = 55^\circ . 26'$

To find AB.

As Radius $= s, 90^\circ$ 10,000000
: AC - 340 2,531479.
:: $s, \angle C$ $55^\circ . 26'$ 9,915646
: AB - 280 2,447125

By Gunter's Log. Scale.

1. Extend from 340 to 193 in the line of numbers; that extent will reach from $s, 90^\circ$, to $s, 34^\circ . 34'$ in the line of sines. Whence the angle A being $34^\circ . 34'$, the $\angle C$ must be $55^\circ . 26'$ its comp.

To find AB.

2. Extend from $s, 90$ to $s, 55^\circ . 26'$, which extent will reach from 340 to 280 in the line of numbers.

C A S E IV. and V. of Right Angled Triangles.

The angles and one leg being given, to find the hypotenuse is Case 4. To find the other leg is Case 5. (See Art. 4. p. 24.)

Fig. 6.

In the triangle ABC, are given, $\angle A 34^\circ. 34'$, the leg or base AB 280, and the $\angle C 55^\circ. 26'$. Required, the hypotenuse AC, and perpendicular BC.

To construct the Figure.

1. Draw the base AB=280.
2. With the chord of 60° , and one foot in A, describe the arch *de*.
3. Draw a line from A, through the section *e*, as found in Case 1.
4. Erect a perpendicular on B, to cut the line drawn through *e*, in the point C, and the triangle is formed.

Solution. By construction AC measures 340, and BC 192,9, as before.

By Logarithms.

To find BC. (Theo. 2.)		To find AC.	
As s, $\angle C 55^\circ. 26'$ co-ar.	= 0,084354	As s, $\angle C 55^\circ. 26'$ co ar.	= 0,084354
: AB - 280	= 2,447158	: AB 280	= 2,447158
:: s, $\angle A 34^\circ. 34'$	= 9,753862	:: Rad.	= 10 . . .
: BC - 192,9	= 2,285374	: AC 340	= 2,531512

By Gunter's Log. Scale.

1. Extend from s, $55^\circ. 26'$ to 280 in the line of numbers, that extent will reach from s, $34^\circ. 34'$ to 193 in the numbers.
2. Extend from s, $55^\circ. 26'$ to s, 90° , that extent will reach from 280 to 340 in the numbers. Hence AB=280, and AC=340.

C A S E VI. and VII.

The base and perpendicular being given, to find the angles, is Case 6. To find the hypotenuse is Case 7.

Fig. 7.

In the right angled triangle ABC, are given AB=86,6 and BC=50. Required AC, and the angles A and C.

To construct the Figure.

1. Draw the base AB=86,6
2. On B, erect the perpendicular BC=50.
3. Draw the hypotenuse AC, and the triangle is formed.

Solution. By construction, AC measures 100, $\angle A 30^\circ$, and $\angle C = 60^\circ$.

By Logarithms.

To find the Angle A. (Theo. 1.)		To find AC.	
As AB - 86,6	= 1,937518	As s, $\angle A 30^\circ = 9,698970$	
: BC - 50	= 1,698970	: BC 50 = 1,698970	
:: t. of $45^\circ = R$	= 10 . . .	:: Rad. = 10 . . .	
: t. of $\angle A 30^\circ. 00'$	= 9,761452	: AC 100 = 2,000000	
The comp. of $\angle A 60^\circ. 00'$ is $\angle C$.			

By Gunter's Log. Scale.

1. Extend from s, 30 to s, 90, that extent will reach from 50 in the numbers to 100=AC.
2. Extend from 86,6 to 50 in the numbers, that extent will reach from t, 45° to t, $30^\circ = \angle A$. Hence the $\angle C$ must be 60° , the comp. of $\angle A$ to 90° .

C A S E

C A S E I. of Oblique Angled Triangles.

The angles and one side being given, to find the other sides.
In the triangle ABC, are given $AB = 106$ feet,

Fig. 8.

$$\begin{array}{r} \angle A = 44^{\circ} . 44' \\ \angle B = 89 . 00 \\ \hline \text{Sum} = 133 . 44 \\ 3 \angle s = 180 . 00 \\ \hline \text{Rem. } \angle C = 46 . 16 \end{array}$$

To construct the Figure.

1. Draw a right line AC for the base of the figure.
2. With the chord of 60° , on A, describe ab .
3. Set the given $\angle A$, from b to a , and draw AB, to pass through the point a .
4. Make $AB = 106$, taken from a scale of equal parts.
5. On the point B, describe (with the chord of 60) an arc ef , and set the $\angle B 89^{\circ}$ from e to f ; draw BC, thro' f , till it meet with the base AC, and then the triangle is formed.

Solution. By construction, AC measures 146

BC do. - 103

By Logarithms.

To find AC. By Theo. 2.

$$\begin{array}{r} \text{As } s, \angle B 46^{\circ} . 16' \text{ co-ar.} = 0,141123 \\ : AB - 106 = 2,025306 \\ :: s, \angle B 89 . 00 = 9,999934 \\ : AC - 146,7 = 2,166363 \end{array}$$

To find BC.

$$\begin{array}{r} \text{As } s, \angle C 46^{\circ} . 16' \text{ co-ar.} = 0,141123 \\ : AB - 106 = 2,025306 \\ :: s, \angle A 44 . 44 = 9,847454 \\ : BC - 103,2 = 2,013883 \\ \text{Nearest log.} - - - 2,013680 \\ \hline \text{Diff.} - - - - - 203 \end{array}$$

Now say, if the difference of the logs. 420 give 10, what will the difference 203 give?
Ans. 4,83. Hence $BC = 103,2483$. But 103,25 is sufficiently near for practice.

Note. If AC be found to five places of figures it will be 146,68.

By Gunter's Scale.

1. Extend from $s, 46^{\circ} . 16'$ to sine 89° , that extent will reach from 106 to $146\frac{1}{2}$ on the line of numbers, equal to AC.
2. Extend from $s, 46^{\circ} . 16'$ to 106 in the numbers, and that extent will reach from the $s, 44^{\circ} . 44'$ to 103 = BC, in the numbers.

C A S E II. and III. of Oblique Triangles.

Two sides and an angle opposite to one of them being given, to find the other angles, is Case 2. To find the other side is Case 3.

In the triangle ABC are given $AB = 19$ miles, $AC = 30,5$, and the angle $B = 89^{\circ}$, Fig. 9, to find the angle A.

To construct the Figure.

1. Draw an oblique line, as AB, which make equal to 19.
2. On the point B, with the chord of 60 , describe an arch, as ef , and set from e to f , the chord of the given angle 89° , and draw a line from B to f , to pass through the point f , if occasion require.
3. Take AC in the compasses, and with one foot on A, make a section in the line Bf, as at C, draw AC, and the triangle will be formed.

Solution. By construction, the $\angle C$ measures $38^{\circ} . 30'$ } And BC measures 24 miles.
And $\angle A - - - 52 . 30$ }

By

By Logarithms. (Theo. 2.)

$$\begin{array}{rcl}
 \text{As AC } 30,5 \text{ co-ar.} & = & 8,51571 \\
 : \text{AB } 19 & = & 1,27875 \\
 :: s, \angle B 89^\circ . 00' & = & 9,99993 \\
 : s, \angle C 38 . 31 & = & 9,79439
 \end{array}$$

The sum is $127 . 31$ The sup. is $\angle A 52 . 29$

$$\begin{array}{rcl}
 \text{As } s, 38^\circ . 31' \text{ co-ar.} & = & 0,20561 \\
 : s, 52 . 29 & = & 9,89936 \\
 :: \text{AB } 19 & = & 1,27875 \\
 : \text{BC } 24,2 & = & 1,38372
 \end{array}$$

Ans. the $\angle A$ is $52^\circ . 29'$

And the length of BC is 24 miles.

C A S E IV. and V. of Obliques.

The two sides, and the included angle being given, to find the other angles, is Case 4. and to find the other side, is Case 5.

Fig. 10. In the triangle ABC, are given AB 106, BC 103, the contained angle B 89° .

To construct the Figure.

1. Make the line AB 106 equal parts.
2. Set off the angle B, as in the foregoing fig. and draw BC = 103.
3. Draw a line from B to C, and the fig. will be constructed.

Solution. By construction, angle A measures 45° . nearly.

$$\begin{array}{rcl}
 \text{AB } 106 & 180 \\
 \text{AC } 103 & -89 \\
 \hline
 \text{Sum } 209 & 91 \text{ the sum of the angles A and C.} \\
 \text{Diff. } 003 & 45^\circ . 30' \text{ is half the sum of the angles.}
 \end{array}$$

By Logarithms. (By Theo. 3.)

$$\begin{array}{rcl}
 \text{As } 209 \text{ co-ar.} & = & 7,67986 \\
 : 3 & = & 0,47712 \\
 :: t, 45^\circ . 30' & = & 9,85324 \\
 : t, \text{of } 0 . 35 & = & 8,01022 \\
 \hline
 \angle C = 46 . 05 \\
 \angle A = 44 . 55
 \end{array}$$

$$\begin{array}{rcl}
 \text{As } s, \angle A 44^\circ . 55' \text{ co-ar.} & = & 0,15115 \\
 : s, \angle 89 . 00 & = & 9,99993 \\
 :: \text{BC } 103 & = & 2,01283 \\
 : \text{AC } 145,9 & = & 2,16391
 \end{array}$$

C A S E VI. Of Oblique Angled Triangles.

The three sides being given, to find an angle.

Fig. 11. In the triangle ABC are given AB = 106, AC = 146,5, and BC = 103,2.

To construct the Figure.

1. Draw the base or longest side AC.
2. With the side AB in the compasses, and one foot in A, describe an arc.
3. With the side BC, and one foot in C, cross the other arc, as at B, and draw the lines AB, CB, and the triangle will be formed.

Solution. By construction, angle A measures $44^\circ \frac{1}{4}$; angle B 89° ; and the angle C $46^\circ \frac{3}{4}$, the sum of the three angles is 180° .

By Logarithms. (Theo. 4.)

To find the segments, or parts, of the base AD, and DC. (By Theo. 4.)

$$\text{AB} + \text{BC} = 209,2$$

$$\begin{array}{rcl}
 \text{As the base AC } 146,5 \text{ co-ar.} & = & 7,834162 \\
 : \text{Sum of the sides } 209,2 & = & 2,320562 \\
 :: \text{Diff. of the sides } 2,8 & = & 0,447158 \\
 : \text{Diff. of the segts. } 3,998 & = & 0,601882
 \end{array}$$

Since the diff. of the segts. is so near to 4, therefore 4 may be taken for it.

$$\text{Now to half the base } \frac{146,5}{2} = 73,25$$

$$\text{Add and subtr. half the } \left. \begin{array}{l} \text{diff. of the segments} \end{array} \right\} \frac{1}{2} = 2,00$$

$$\text{Greater seg. AD} - - = 75,25$$

$$\text{Less ditto DC} - - = 71,25$$

To find the angle A.

$$\text{As AB} - - - 106 = 7,974694$$

$$: R :: AD \ 75,25 = 1,876506$$

$$: \text{cof. } \angle A \ 44^\circ. 46' = 9,851200$$

Which is sufficiently true for common practice.

To find the angle C.

$$\text{As BC} - - - 103,2 = 7,986320$$

$$: R :: DC \ 71,25 = 1,852785$$

$$: \text{cof. } \angle C \ 46^\circ. 20' = 9,839105$$

$$+ \angle A \ 44.46$$

$$\text{Sum of } \angle A + C = 91.06$$

$$\text{Sup. is } \angle B = 88.54$$

PLANE TRIGONOMETRY.

THE use of Plane Trigonometry is, for obtaining the distances of terrestrial Objects from one another, when the distances cannot be conveniently measured by reason of the unevenness of the ground, rivers, building, or other obstacles; those distances seldom exceed ten or twelve miles, and for such distances there must be one side of the triangle measured for a base, which should not be less than one eighth or one tenth of the greatest distance required to be found. But this distance or base greatly depends upon the goodness of the instrument to be used for measuring the angles; and for such purposes the Theodolite is used, with a telescope fixed to its index, and a nonius, to move upon the limb or arch of the instrument, by which angles may be taken to every minute of a degree. When the base is measured, and two of the angles taken by the instrument; then the three angles are known, and the other two sides may be found as follows:

P R O B L E M I.

In the triangle ABC, suppose the side BC = 70 Chains, that is, Gunter's Chains, which Fig. 12, Chain contains 100 links, and is in length 22 yards = 66 feet

$$10 \text{ chains} = 1 \text{ furlong} = 220 \text{ yards.}$$

$$80 \text{ ditto} = 8 \text{ ditto} = 1760 \text{ ditto} = 1 \text{ mile.}$$

$$\text{And the } \angle C = 126^\circ. 52'$$

$$\angle B = 36.52 \frac{1}{4}$$

$$\text{Sum} = 163.44 \frac{1}{4}$$

$$\text{Hence } \angle A = 16.15 \frac{3}{4}$$

To find AB by Case 1. of Obliques.

$$1. \text{ As } s, \angle A : BC :: s, \angle C : AB = 200$$

$$2. \text{ As } s, \angle A : BC :: s, \angle B : AC = 150$$

Suppose the sides AB, BC, and the contained angle C, to be given, as in Case 4. to find the angles.

$$\angle C = 126^\circ. 52'$$

$$\text{Its Sup. } 53.08$$

$$\text{Half Sum of the opposite angles } 26.34$$

$$AC = 150$$

$$BC = 70$$

$$\text{Sum } 220 \text{ its log. co-ar.} = 7,6575773$$

$$\text{Diff. } 80 \text{ its log.} = 1,9030900$$

$$t. \text{ of half sum of op. angles } 26^\circ. 34' = 9,6990006$$

$$t. \text{ of half the diff. of do. } 10.18 \frac{1}{4} = 9,2596679$$

$$\text{The diff. is the angle A } = 16.15 \frac{3}{4}$$

$$\text{The sum is the angle C } = 36.52 \frac{1}{4}$$

The angles obtained are the same as were taken by the instrument, which evidently shews that the sides are truly determined

K

NAUTICAL

NAUTICAL DEFINITIONS.

1. **N**AVIGATION is the art of conducting a ship at sea, from one place or port to another.
2. A degree of any great circle of the earth or heavens, is the 360th part of it; and 60 minutes is equal to one degree.
3. The complement of an arch or angle, or the complement of the latitude of a place, is what the arc, angle, or latitude wants of 90° .
4. The supplement of an arc, or angle, is what it wants of 180° , or of 360° .
5. Complement arithmetical of a log. is what that log. wants of 10, when the log. is less than 10; but when the log. is more than 10,00000 subtract it from 20, to get its co-arith.
6. The course of a ship is either in direction of the meridian North or South, or it is the angle made with the meridian; which angle is of two kinds, the course steered, or the course made good: The difference between them is the lee-way.
7. Lee-way is the difference between the course steered, and the course made by the ship, when she sails near the wind (in a tide or current) and is by it drove off from the course steered to leeward, that is, towards the Coast, to which the wind blows.
8. A rumb, is the path a ship describes during any one course.
9. A rumb-line, intersects all meridians with the same angles; therefore it is a spiral line upon the spherical figure of the earth, and continually approaches the pole; except in an East or West course, where the rumb-line coincides with the parallel of latitude, and in a North or South course with the meridian.
10. Equator, that great circle of the earth where the days and nights are always of equal length. This circle extends about the globe East and West, and from it; latitude is reckoned North and South to 90° each way, to its poles; those poles have no diurnal revolution; but the earth revolves round its axis every twenty-four hours of equal time. (See fig. 1. pl. 2. for this and the following Definitions.)
11. The Latitude of a place is its distance from the equator.
12. The Longitude of a place is the distance between the first meridian and the meridian of that place, reckoned in the Equator.
13. Meridian of a place, is the semi-circle conceived to pass from pole to pole through the zenith of the place.
14. Axis of the earth is an imaginary line, conceived to pass through the center of the earth from pole to pole.
15. The horizon of any place is that where the earth and sky appear to meet; and it is a great circle which may be conceived to divide the surface of the earth and the heavens into two half spheres, which are called the upper and lower hemispheres.
16. The poles of any great circle, are those points of its axis perpendicular to its plane, and at 90° from the center of that circle, on each side it. Poles of the earth are the extremes of its diameter, or axis, round which it appears to turn, or the heavens to revolve.
17. Parallels of latitude, are lesser circles, which may be conceived to pass about the earth parallel to the equator; and therefore two places having the same latitude, North or South, are said to be in the same parallel of latitude.
18. The difference of latitude of two places, is the arch of distance contained, between the parallels of latitude of those places.
19. The difference of longitude of two places is an arch of the equator contained between the meridians of the places.
20. Departure is the Easting and Westing a ship makes, on one or more courses; and when she makes both East and West departure, then their difference is the departure made good.
21. Meridian distance, is the total Easting or Westing made in any number of days.
22. Meridional

22. Meridional Distance, is the distance of any one place from the meridian of any other place; and it is to be reckoned in the parallel of latitude of the given place: Hence the meridional distance of that place in the lesser latitude, would be greater than the meridional distance of the place in the greater latitude, with the same difference of longitude.

23. Meridional difference of latitude, is the meridional parts of the enlarged meridian, contained between the parallels of the latitude of the two places.

24. Plane Sailing is computing a ship's way according to the principles of plane trigonometry.

25. Charts are maps of the sea and sea coasts.

Plane charts have the lat. and lon. equal every where.

Reduced charts have the lon. to the lat. in the ratio of the minutes contained in 1° of lon. to $60'$ of lat. and that, in the parallel of the middle latitude.

26. Middle latitude, the lat. of the place in the middle between the two given latitudes.

27. Variation of the compass, is an arch of the horizon, contained between the meridian of the place, and the North point of the needle, or magnetical meridian.

N A V I G A T I O N.

P L A N E S A I L I N G.

PLANE SAILING is the computing a ship's way by the principles of plane triangles, or plane trigonometry, with regard to its Northing, Southing, Easting and Westing. And near the equator, there is no occasion to use any other kind of sailing, because the degrees of latitude and of longitude are there nearly equal to each other; each degree being equal to 60 minutes, or nautical miles (commonly called geographical miles); each minute or mile contains 6072 feet, or 2024 yards, or 1012 fathoms. [See p. 22].

In this art of conducting ships from one port to another, the commanders have the following instruments, to wit. cabin, binicle and steerage compasses, by which they know the way the ships sail. Some ships have amplitude and azimuth compasses, by which they can determine how much the needle of the compass varies from its pointing to the North; which deviation of direction is called the variation of the compass; and in some places it is East, but in other places it is West variation.

They have also a log, log-line, real, and half-minute glasses, by which they obtain the distances the ships sail in an hour, and in a day; and so on from day to day.

Likewise they have a quadrant, sextant, or octant, by which they obtain the latitude of the ships each day at noon, when they get observations of the sun. Moreover they have maps of the sea, which are called sea charts, wherein they set off from day to day, the lat. and lon. of the Ship, by which the place of the ship is generally noted each day in the chart: Also by that place in the chart, they can see the course and distance they have made from the port sailed from, also the course and distance they are from, any other place or port.

The account of the distance sailed, is generally kept in knots and fathoms on board men of war and East Indiamen; but on board other ships, in knots, half knots and fathoms: The distance of each knot of the log-line, is 7 fathoms, for a sand glass that runs out in 28 seconds; but for half a minute glass, the length or distance of each knot is generally eight fathoms, or 48 feet; but the true distance of each knot for a half minute glass, is the 120th part of a nautical mile. And since the degrees of latitude are of different lengths, from the equator to the poles, increasing, and occasioned by the spheroidal fig. of the earth, therefore if we take the mean length of a degree of latitude, which is 69 English miles, $69 \times 880 = 60720$ fathoms $= 12144$ yards $= 364320$ feet in 1° of latitude; hence $\frac{1}{60}$ of $364320 = 6072$, the feet in 1 nautical mile, or minute: But $\frac{1}{110}$ of 6072 is 55,6 feet, for the true distance of the knots of the log-line.

The

The reason for the distance of each knot being made only 48 feet, for a half-minute glass, is to make some allowance for the way the log may make after the ship.

Remark 1. In drawing the construction of any case or Problem of plane sailing, middle latitude, Mercators, &c. you are to make the top of the paper, book, or slate, to represent the North; the bottom South; the right hand side East; and the left hand side West.

Remark 2. The difference of latitude is the North and South line, and it is generally called the meridian; the departure is the East or West line; and the distance is either North, South, East or West; or in oblique courses the hypotenuse is the distance: For in oblique courses, the course is contained by or between the meridian and the distance line; and the complement of the course between the departure and the distance, and opposite to the diff. of lat.

The following canons, or proportions, are sufficient to inform the learner, how to answer all the cases of plane sailing, in nautical terms.

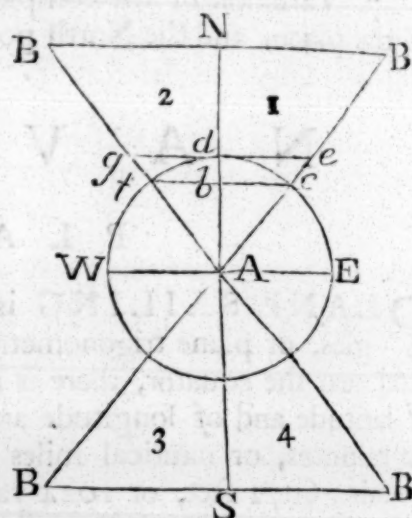
In the annexed figure,

The line AN represents the difference of latitude North; AS the diff. of lat. South; AB the distance; and NB or SB the departure, whether it be East or West.

The angle A, the course steered from A to B, making the angle BAS, or BAN, with the meridian SN.

The angle B is the complement of the course to 90° .

In the figure, A represents the place sailed from, and B the place arrived at; which place (B) may be in any of the quarters of the horizon: Hence it appears that the difference of latitude, the departure, and distance, make a right angled triangle, the right angle is at N or S, whose sine is always called the radius.



Cafe.	Given.	Required.	Proportions.
1	Course and Distance.	Diff. Lat. and Dep.	R : Dist. :: cos. Course : Diff. Latitude R : Dist. :: sine Course : Departure
2	Course and Dep.	The Dist. & Diff. Lat.	Sine Course : Dep. :: R : Distance Sine Course : Dep. :: Cos. Course : Diff. Lat.
3	Course and Diff. Lat.	The Dist. & Dep.	Cos. Course : Diff. Lat. :: R : Dist. Cos. Course : Diff. Lat. :: Sine Course : Dep.
4	Dist. and Dep.	Course and Diff. Lat.	Dist. : R :: Dep. : Sine Course. R : Dist. :: Cos. Course : Diff. Lat.
5	Dist. and Diff. Lat.	The Course and Depart.	Dist. : R :: Diff. Lat. : Cos. Course. R : Dist. :: Sine Course : Departure.
6	Diff. Lat. and Dep.	The Course and Dist.	Diff. Lat. : Dep. :: Tan. 45° : Tan. Course Sine Course : Dep. :: R : Distance.

Note, That the proportions of the first Cafe are to be read thus: The radius is to the distance, so is the cosine of the course, to the difference of latitude.

And the radius is to the distance, so is the sine of the course to the departure. And the like of the other cafes,

Observe, in Triangle 1. or ANB, the course is in the N.E. quarter; in Triangle 2. the course is in the N.W. quarter; in Triangle 3. the course is in the S.W. quarter; and in Triangle 4. the course is in the S.E. quarter.

N.B. The right lines bc , bt , represent the sine of the course, and de , dg , the tangent of ditto. The arch dc , dt , the measure of the angle of the course.

Traverse Table for $\frac{1}{4}$ Point, or N. $\frac{1}{4}$ E. N. $\frac{1}{4}$ W. S. $\frac{1}{4}$ E. S. $\frac{1}{4}$ W.

Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.
1	0,9988	0,049	51	50,939	2,502	101	100,88	4,96	151	150,82	7,31
2	1,998	0,098	52	51,938	2,552	102	101,88	5,00	152	151,82	7,36
3	2,996	0,147	53	52,936	2,601	103	102,88	5,05	153	152,82	7,41
4	3,995	0,196	54	53,935	2,655	104	103,88	5,10	154	153,82	7,46
5	4,994	0,245	55	54,934	2,699	105	104,87	5,15	155	154,81	7,51
6	5,993	0,294	56	55,933	2,748	106	105,87	5,20	156	155,81	7,56
7	6,992	0,343	57	56,932	3,797	107	106,87	5,25	157	156,81	7,60
8	7,990	0,392	58	57,930	3,846	108	107,87	5,30	158	157,81	7,65
9	8,989	0,442	59	58,929	3,895	109	108,87	5,35	159	158,81	7,70
10	9,888	0,491	60	59,928	3,844	110	109,87	5,40	160	159,81	7,75
11	10,987	0,540	61	60,927	3,993	111	110,87	5,45	161	160,81	7,80
12	11,986	0,589	62	61,926	3,042	112	111,87	5,50	162	161,81	7,85
13	12,984	0,638	63	62,924	3,091	113	112,86	5,54	163	162,80	7,89
14	13,983	0,687	64	63,923	3,140	114	113,86	5,59	164	163,80	7,95
15	14,982	0,736	65	64,922	3,189	115	114,86	5,64	165	164,80	8,00
16	15,981	0,785	66	65,921	3,239	116	115,86	5,69	166	165,80	8,05
17	16,980	0,834	67	66,920	3,288	117	116,86	5,74	167	166,80	8,10
18	17,978	0,883	68	67,918	3,337	118	117,86	5,79	168	167,80	8,14
19	18,977	0,932	69	68,917	3,386	119	118,86	5,84	169	168,80	8,19
20	19,976	0,981	70	69,916	3,435	120	119,86	5,89	170	169,80	8,24
21	20,975	1,030	71	70,915	3,484	121	120,86	5,94	171	170,79	8,29
22	21,974	1,079	72	71,914	3,533	122	121,85	5,99	172	171,79	8,34
23	22,972	1,129	73	72,912	3,582	123	122,85	6,04	173	172,79	8,39
24	23,971	1,168	74	73,911	3,631	124	123,85	6,09	174	173,79	8,44
25	24,970	1,227	75	74,910	3,680	125	124,85	6,13	175	174,79	8,49
26	25,969	1,276	76	75,910	3,729	126	125,85	6,18	176	175,79	8,54
27	26,968	1,325	77	76,909	3,778	127	126,85	6,23	177	176,79	8,59
28	27,966	1,374	78	77,907	3,827	128	127,85	6,28	178	177,79	8,64
29	28,965	1,423	79	78,906	3,876	129	128,85	6,23	179	178,79	8,68
30	29,964	1,472	80	79,904	3,926	130	129,84	6,28	180	179,78	8,73
31	30,963	1,521	81	80,903	3,975	131	130,84	6,33	181	180,78	8,78
32	31,962	1,570	82	81,902	4,024	132	131,84	6,38	182	181,78	8,83
33	32,960	1,619	83	82,900	4,071	133	132,84	6,42	183	182,78	8,88
34	33,959	1,668	84	83,899	4,122	134	133,84	6,48	184	183,78	8,93
35	34,958	1,717	85	84,898	4,171	135	134,84	6,53	185	184,78	8,98
36	35,957	1,766	86	85,897	4,220	136	135,84	6,57	186	185,78	9,04
37	36,956	1,815	87	86,896	4,269	137	136,84	6,62	187	186,78	9,08
38	37,954	1,865	88	87,894	4,318	138	137,83	6,67	188	187,77	9,13
39	38,953	1,914	89	88,893	4,367	139	138,83	6,72	189	188,77	9,18
40	39,952	1,963	90	89,892	4,416	140	139,83	6,77	190	189,77	9,22
41	40,951	2,012	91	90,891	4,565	141	140,83	6,82	191	190,77	9,27
42	41,950	2,061	92	91,890	4,514	142	141,83	6,87	192	191,77	9,32
43	42,948	2,110	93	92,888	4,563	143	142,83	6,92	193	192,77	9,37
44	43,947	2,159	94	93,887	4,612	144	143,83	6,97	194	193,77	9,42
45	44,946	2,208	95	94,886	4,662	145	144,83	7,02	195	194,77	9,47
46	45,945	2,267	96	95,885	4,711	146	145,82	7,06	196	195,76	9,52
47	46,944	2,306	97	96,884	4,760	147	146,82	7,11	197	196,76	9,57
48	47,942	2,355	98	97,882	4,809	148	147,82	7,16	198	197,76	9,62
49	48,941	2,404	99	98,881	4,860	149	148,82	7,21	199	198,76	9,67
50	49,940	2,453	100	99,880	4,907	150	149,82	7,26	200	199,76	9,72
Diff.	Dep.	D.Lat.	Diff.	Dep.	D.Lat.	Diff.	Dep.	D.Lat.	Diff.	Dep.	D.Lat.

E. $\frac{1}{4}$ N. E. $\frac{1}{2}$ S. W. $\frac{1}{4}$ N. W. $\frac{1}{2}$ S. or 7 $\frac{1}{4}$ Points from the Meridian.

Traverse Table for $\frac{1}{2}$ Point. N. $\frac{1}{2}$ E. N. $\frac{1}{2}$ W. S. $\frac{1}{2}$ E. S. $\frac{1}{2}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,995	0,098	51	50,754	4,999	101	100,51	9,90	151	150,26	14,80
2	1,990	0,196	52	51,749	5,097	102	101,51	10,00	152	151,26	14,90
3	2,985	0,294	53	52,744	5,195	103	102,50	10,09	153	152,25	15,00
4	3,981	0,392	54	53,740	5,293	104	103,50	10,19	154	153,25	15,10
5	4,976	0,490	55	54,735	5,391	105	104,49	10,29	155	154,24	15,20
6	5,971	0,588	56	55,730	5,489	106	105,49	10,39	156	155,24	15,29
7	6,966	0,686	57	56,725	5,587	107	106,48	10,49	157	156,23	15,39
8	7,961	0,784	58	57,720	5,685	108	107,48	10,58	158	157,23	15,48
9	8,952	0,882	59	58,717	5,783	109	108,47	10,68	159	158,22	15,58
10	9,952	0,980	60	59,711	5,881	110	109,47	10,78	160	159,22	15,68
11	10,947	1,078	61	60,706	5,979	111	110,46	10,88	161	160,21	15,78
12	11,942	1,176	62	61,701	6,077	112	111,46	10,99	162	161,21	15,88
13	12,937	1,274	63	62,696	6,175	113	112,45	11,08	163	162,20	15,97
14	13,932	1,372	64	63,691	6,273	114	113,45	11,18	164	163,20	16,07
15	14,928	1,470	65	64,687	6,371	115	114,44	11,28	165	164,19	16,17
16	15,923	1,568	66	65,682	6,469	116	115,44	11,38	166	165,19	16,27
17	16,918	1,666	67	66,677	6,567	117	116,43	11,47	167	166,18	16,37
18	17,913	1,764	68	67,672	6,665	118	117,43	11,56	168	167,18	16,46
19	18,908	1,862	69	68,667	6,763	119	118,42	11,66	169	168,17	16,56
20	19,904	1,960	70	69,663	6,861	120	119,42	11,76	170	169,18	16,66
21	20,899	2,058	71	70,658	6,959	121	120,41	11,86	171	170,16	16,76
22	21,899	2,156	72	71,653	7,057	122	121,41	11,96	172	171,16	16,86
23	22,889	2,254	73	72,648	7,155	123	122,40	12,05	173	172,15	16,95
24	23,884	2,352	74	73,643	7,253	124	123,40	12,15	174	173,15	17,05
25	24,879	2,450	75	74,638	7,351	125	124,39	12,25	175	174,14	17,15
26	25,875	2,548	76	75,634	7,449	126	125,39	12,35	176	175,14	17,25
27	26,870	2,646	77	76,629	7,547	127	126,38	12,45	177	176,13	17,35
28	27,865	2,744	78	77,624	7,645	128	127,38	12,54	178	177,13	17,44
29	28,860	2,842	79	78,619	7,743	129	128,37	12,64	179	178,12	17,54
30	29,855	2,941	80	79,614	7,842	130	129,37	12,74	180	179,12	17,64
31	30,850	3,039	81	80,609	7,940	131	130,36	12,84	181	180,11	17,74
32	31,846	3,137	82	81,605	8,038	132	131,36	12,94	182	181,11	17,84
33	32,841	3,235	83	82,600	8,136	133	132,35	13,03	183	182,10	17,93
34	33,836	3,333	84	83,595	8,234	134	133,35	13,13	184	183,10	18,03
35	34,831	3,431	85	84,590	8,332	135	134,34	13,23	185	184,09	18,13
36	35,826	3,529	86	85,585	8,430	136	135,34	13,33	186	185,09	18,23
37	36,822	3,627	87	86,581	8,528	137	136,33	13,43	187	186,08	18,33
38	37,817	3,725	88	87,576	8,626	138	137,33	13,52	188	187,08	18,42
39	38,812	3,823	89	88,571	8,724	139	138,32	13,62	189	188,07	18,52
40	39,807	3,921	90	89,566	8,822	140	139,32	13,72	190	189,07	18,62
41	40,802	4,019	91	90,561	8,920	141	140,31	13,82	191	190,06	18,72
42	41,797	4,117	92	91,556	9,018	142	141,31	13,92	192	191,06	18,82
43	42,793	4,215	93	92,552	9,116	143	142,30	14,01	193	192,06	18,91
44	43,788	4,313	94	93,547	9,214	144	143,30	14,11	194	193,05	19,01
45	44,783	4,411	95	94,542	9,312	145	144,29	14,21	195	194,05	19,11
46	45,778	4,509	96	95,537	9,410	146	145,29	14,31	196	195,04	19,21
47	46,773	4,607	97	96,532	9,508	147	146,28	14,41	197	196,04	19,31
48	47,769	4,705	98	97,528	9,606	148	147,28	14,50	198	197,04	19,40
49	48,764	4,803	99	98,523	9,704	149	148,27	14,60	199	198,04	19,50
50	49,759	4,901	100	99,518	9,822	150	149,28	14,70	200	199,00	19,60
Dist.	Dep.	D. Lat.	Dist.	Dep.	L. t	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

For $7\frac{1}{2}$ Points. E b N $\frac{1}{2}$ E. W b N $\frac{1}{2}$ W. E b S $\frac{1}{2}$ E. W b S $\frac{1}{2}$ W. or E. $\frac{1}{2}$ N. E $\frac{1}{2}$ S. W $\frac{1}{2}$ N. W $\frac{1}{2}$ S.

Traverse Table for $\frac{1}{4}$ Point, or N. $\frac{1}{4}$ E. N. $\frac{1}{4}$ W. S. $\frac{1}{4}$ E. S. $\frac{1}{4}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,98918	0,14674	51	50,4481	7,4837	101	99,907	14,821	151	149,365	22,156
2	1,9784	0,2935	52	51,4376	7,6304	102	100,896	14,967	152	150,354	22,303
3	2,9675	0,4402	53	52,4267	7,7771	103	101,885	15,114	153	151,343	22,450
4	3,9567	0,5869	54	53,4160	7,9238	104	102,875	15,261	154	152,333	22,597
5	4,9459	0,7337	55	54,4051	8,0705	105	103,864	15,407	155	153,322	22,743
6	5,9351	0,8804	56	55,3944	8,2172	106	104,853	15,554	156	154,312	22,890
7	6,9242	1,0271	57	56,3835	8,3639	107	105,842	15,701	157	155,301	22,037
8	7,9134	1,1738	58	57,3728	8,5106	108	106,832	15,848	158	156,290	23,185
9	8,9026	1,3206	59	58,3619	8,6573	109	107,821	15,994	159	157,279	23,332
10	9,8918	1,4674	60	59,3508	8,8044	110	108,810	16,141	160	158,269	23,478
11	10,8810	1,6141	61	60,3399	8,9511	111	109,799	16,288	161	159,258	23,625
12	11,8702	1,7609	62	61,3290	9,0978	112	110,789	16,434	162	160,247	23,772
13	12,8594	1,9076	63	62,3181	9,2445	113	111,778	16,581	163	161,236	23,918
14	13,8486	2,0543	64	63,3072	9,3912	114	112,767	16,628	164	162,225	24,065
15	14,8377	2,2011	65	64,2963	9,5379	115	113,756	16,774	165	163,214	24,212
16	15,8268	2,3478	66	65,2854	9,6846	116	114,746	17,021	166	164,203	24,359
17	16,8160	2,4945	67	66,2745	9,8313	117	115,735	17,168	167	165,192	24,505
18	17,8052	2,6412	68	67,2640	9,9780	118	116,724	17,315	168	166,182	24,652
19	18,7944	2,7879	69	68,2531	10,1247	119	117,713	17,461	169	167,171	24,799
20	19,7836	2,9348	70	69,2426	10,2714	120	118,702	17,609	170	168,161	24,945
21	20,7728	3,0815	71	70,2317	10,4181	121	119,691	17,755	171	169,150	25,092
22	21,7620	3,2282	72	71,2208	10,5648	122	120,680	17,902	172	170,139	25,239
23	22,7512	3,3749	73	72,2099	10,7115	123	121,669	18,049	173	171,128	25,385
24	23,7404	3,5218	74	73,1990	10,8582	124	122,658	18,196	174	172,117	25,532
25	24,7296	3,6685	75	74,1881	11,0049	125	123,647	18,342	175	173,106	25,679
26	25,7188	3,8152	76	75,1772	11,1516	126	124,636	18,489	176	174,096	25,826
27	26,7080	3,9619	77	76,1668	11,2983	127	125,625	18,636	177	175,085	25,972
28	27,6972	4,1086	78	77,1558	11,4450	128	126,614	18,782	178	176,074	26,119
29	28,6864	4,2553	79	78,1449	11,5927	129	127,603	18,929	179	177,063	26,266
30	29,6756	4,4022	80	79,1344	11,7392	130	128,593	19,076	180	178,052	26,413
31	30,6645	4,5489	81	80,1235	11,8859	131	129,582	19,222	181	179,041	26,560
32	31,6536	4,6956	82	81,1126	12,0326	132	130,561	19,369	182	180,031	26,707
33	32,6427	4,8423	83	82,1017	12,1793	133	131,550	19,516	183	181,020	26,853
34	33,6320	4,9890	84	83,0912	12,3260	134	132,549	19,663	184	182,009	26,999
35	34,6211	5,1357	85	84,0803	12,4727	135	133,538	19,809	185	182,998	27,146
36	35,6104	5,2824	86	85,0694	12,6194	136	134,528	19,956	186	183,988	27,293
37	36,5995	5,4291	87	86,0585	12,7661	137	135,517	20,103	187	184,977	27,439
38	37,5886	5,5758	88	87,0480	12,9128	138	136,506	20,249	188	185,966	27,586
39	38,5779	5,7225	89	88,0371	13,0595	139	137,495	20,396	189	186,955	27,733
40	39,5672	5,8696	90	89,0262	13,2066	140	138,485	20,543	190	187,944	27,879
41	40,5563	6,0163	91	90,0153	13,3533	141	139,474	20,689	191	188,933	28,026
42	41,5456	6,1630	92	91,0048	13,4996	142	140,463	20,836	192	189,923	28,174
43	42,5347	6,3097	93	91,9939	13,6463	143	141,452	20,983	193	190,912	28,321
44	43,5240	6,4564	94	92,9830	13,7930	144	142,442	21,130	194	191,901	28,468
45	44,5131	6,6031	95	93,9721	13,9397	145	143,431	21,276	195	192,890	28,614
46	45,5024	6,7498	96	94,9616	14,0872	146	144,420	21,423	196	193,880	28,761
47	46,4915	6,8965	97	95,9507	14,2339	147	145,409	21,570	197	194,869	28,908
48	47,4808	7,0436	98	96,9398	14,3806	148	146,398	21,716	198	195,858	29,058
49	48,4699	7,1903	99	97,9280	14,5273	149	147,387	21,863	199	196,847	29,204
50	49,4590	7,3370	100	98,918	14,6740	150	148,376	22,010	200	197,836	29,348
Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.

For $\frac{1}{4}$ Point, or E b N $\frac{1}{4}$ E. E b S $\frac{1}{4}$ E. W b N $\frac{1}{4}$ W. W b S $\frac{1}{4}$ W.

Traverse Table for 1 Point. N. b. E. N. b. W. S. b. E. S. b. W.

Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.
1	0,981	0,195	51	50,021	9,950	101	99,06	19,70	151	148,10	29,46
2	1,963	0,390	52	51,002	10,145	102	100,04	19,90	152	149,08	29,65
3	2,943	0,585	53	51,982	10,340	103	101,02	20,09	153	150,06	29,85
4	3,924	0,780	54	52,963	10,535	104	102,00	20,29	154	151,04	30,05
5	4,905	0,975	55	53,941	10,730	105	102,98	20,49	155	152,02	30,24
6	5,886	1,170	56	54,925	10,926	106	103,96	20,68	156	153,00	30,44
7	6,867	1,366	57	55,906	11,121	107	104,95	20,88	157	153,99	30,63
8	7,848	1,561	58	56,887	11,316	108	105,93	21,07	158	154,97	30,83
9	8,829	1,756	59	57,867	11,511	109	106,91	21,27	159	155,95	31,02
10	9,801	1,951	60	58,847	11,705	110	107,89	21,46	160	156,93	31,22
11	10,781	2,146	61	59,829	11,901	111	108,87	21,66	161	157,91	31,41
12	11,770	2,336	62	60,108	12,096	112	109,85	21,85	162	158,89	31,61
13	12,751	2,531	63	61,790	12,291	113	110,83	22,05	163	159,87	31,80
14	13,742	2,726	64	62,771	12,486	114	111,81	22,24	164	160,85	32,00
15	14,723	2,921	65	63,762	12,681	115	112,79	22,44	165	161,83	32,19
16	15,704	3,116	66	64,743	12,877	116	113,77	22,63	166	162,81	32,39
17	16,685	3,311	67	65,724	13,072	117	114,75	22,83	167	163,79	32,58
18	17,666	3,506	68	66,704	13,267	118	115,73	23,02	168	164,77	32,78
19	18,647	3,701	69	67,685	13,462	119	116,71	23,22	169	165,75	32,97
20	19,616	3,902	70	68,665	13,656	120	117,70	23,41	170	166,73	33,16
21	20,597	4,097	71	69,647	13,852	121	118,68	23,61	171	167,71	33,36
22	21,578	4,292	72	70,628	14,047	122	119,66	23,80	172	168,69	33,56
23	22,559	4,387	73	71,608	14,242	123	120,64	24,00	173	169,67	33,75
24	23,540	4,582	74	72,589	14,437	124	121,61	24,19	174	170,65	33,95
25	24,521	4,777	75	73,570	14,632	125	122,60	24,39	175	171,63	34,14
26	25,502	4,972	76	74,551	14,828	126	123,58	24,58	176	172,61	34,34
27	26,483	5,167	77	75,532	15,023	127	124,56	24,78	177	173,59	34,53
28	27,464	5,352	78	76,513	15,218	128	125,54	24,97	178	174,57	34,73
29	28,445	5,547	79	77,493	15,413	129	126,52	25,17	179	175,55	34,92
30	29,424	5,853	80	78,463	15,607	130	127,50	25,36	180	176,53	35,12
31	30,405	6,048	81	79,436	15,803	131	128,48	25,56	181	177,51	35,31
32	31,386	6,243	82	80,417	15,998	132	129,47	25,75	182	178,50	35,51
33	32,367	6,438	83	81,391	16,193	133	130,45	25,95	183	179,48	35,70
34	33,348	6,633	84	82,378	16,388	134	131,43	26,14	184	180,46	35,90
35	34,329	6,828	85	83,359	16,583	135	132,41	26,34	185	181,44	36,09
36	35,310	7,023	86	84,340	16,779	136	133,39	26,53	186	182,42	36,29
37	36,291	7,218	87	85,321	16,974	137	134,37	26,73	187	183,40	36,48
38	37,272	7,413	88	86,301	17,169	138	135,35	26,92	188	184,38	36,68
39	38,253	7,608	89	87,282	17,364	139	136,33	27,12	189	185,36	36,87
40	39,231	7,804	90	88,271	17,558	140	137,31	27,31	190	186,34	37,07
41	40,212	7,999	91	89,244	17,754	141	138,29	27,51	191	187,32	37,26
42	41,193	8,194	92	90,225	17,949	142	139,27	27,70	192	188,30	37,46
43	42,173	8,389	93	91,205	18,144	143	140,25	27,90	193	189,28	37,65
44	43,154	8,584	94	92,186	18,339	144	141,23	28,10	194	190,27	37,85
45	44,135	8,779	95	93,167	18,534	145	142,22	28,29	195	191,25	38,04
46	45,116	8,974	96	94,148	18,730	146	143,20	28,48	196	192,23	38,24
47	46,097	9,069	97	95,129	18,925	147	144,18	28,68	197	193,21	38,43
48	47,078	9,264	98	96,109	19,120	148	145,16	28,87	198	194,19	38,63
49	48,059	9,459	99	97,090	19,314	149	146,14	29,07	199	195,17	38,82
50	49,039	9,754	100	98,079	19,509	150	147,12	29,26	200	196,15	39,02
Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.

Seven Points. E. b. N. E. b. S. W. b. N. W. b. S.

Traverse Table for 1 $\frac{1}{4}$ Point. N. b E. $\frac{1}{4}$ E. N. b W. $\frac{1}{4}$ W. S. b E. $\frac{1}{4}$ E. S. b W. $\frac{1}{4}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,970	0,243	51	49,470	12,392	101	97,970	24,54	151	146,47	36,68
2	1,940	0,486	52	50,440	12,635	102	98,940	24,78	152	147,44	36,92
3	2,910	0,729	53	51,410	12,878	103	99,910	25,03	153	148,41	37,17
4	3,880	0,972	54	52,380	13,121	104	100,88	25,27	154	149,38	37,41
5	4,850	1,215	55	53,350	13,364	105	101,85	25,51	155	150,35	37,65
6	5,820	1,458	56	54,320	13,607	106	102,82	25,75	156	151,32	37,90
7	6,790	1,701	57	55,290	13,850	107	103,79	25,99	157	152,29	38,14
8	7,760	1,944	58	56,260	14,093	108	104,76	26,23	158	153,26	38,38
9	8,730	2,187	59	57,230	14,336	109	105,73	26,48	159	154,23	38,63
10	9,700	2,490	60	58,200	14,579	110	106,70	26,72	160	155,20	38,87
11	10,670	2,673	61	59,170	14,822	111	107,67	26,96	161	156,17	39,11
12	11,640	2,916	62	60,140	15,065	112	108,64	27,20	162	157,14	39,35
13	12,610	3,159	63	61,110	15,308	113	109,61	27,45	163	158,11	39,60
14	13,580	3,402	64	62,080	15,551	114	110,58	27,69	164	159,08	39,84
15	14,550	3,645	65	63,050	15,794	115	111,55	27,93	165	160,05	40,08
16	15,520	3,888	66	64,020	16,037	116	112,52	28,18	166	161,02	40,33
17	16,490	4,131	67	64,990	16,280	117	113,49	28,42	167	161,99	40,57
18	17,460	4,374	68	65,960	16,523	118	114,46	28,66	168	162,96	40,81
19	18,430	4,617	69	66,930	16,766	119	115,43	28,91	169	163,93	41,06
20	19,400	4,860	70	67,900	17,009	120	116,40	29,15	170	164,90	41,30
21	20,370	5,103	71	68,870	17,252	121	117,37	29,39	171	165,87	41,54
22	21,340	5,346	72	69,840	17,495	122	118,34	29,63	172	166,84	41,78
23	22,310	5,589	73	70,810	17,738	123	119,31	29,88	173	167,82	42,03
24	23,280	5,832	74	71,780	17,981	124	120,28	30,12	174	168,78	42,27
25	24,250	6,175	75	72,750	18,224	125	121,25	30,36	175	169,75	42,51
26	25,220	6,418	76	73,720	18,467	126	122,22	30,61	176	170,72	42,76
27	26,190	6,661	77	74,690	18,710	127	123,19	30,85	177	171,69	43,00
28	27,160	6,904	78	75,660	18,953	128	124,16	31,09	178	172,66	43,24
29	28,130	7,147	79	76,630	19,196	129	125,13	31,34	179	173,63	43,49
30	29,100	7,289	80	77,600	19,439	130	126,10	31,58	180	174,60	43,73
31	30,070	7,532	81	78,570	19,682	131	127,07	31,82	181	175,57	43,97
32	31,040	7,775	82	79,540	19,925	132	128,04	32,06	182	176,54	44,21
33	32,010	8,018	83	80,510	20,168	133	129,01	32,31	183	177,51	44,46
34	32,980	8,261	84	81,480	20,411	134	129,98	32,55	184	178,48	44,70
35	33,950	8,504	85	82,450	20,654	135	130,95	32,79	185	179,45	44,94
36	34,920	8,747	86	83,420	20,897	136	131,92	33,04	186	180,42	45,19
37	35,890	8,990	87	84,390	21,140	137	132,89	33,28	187	181,39	45,43
38	36,860	9,233	88	85,360	21,383	138	133,86	33,52	188	182,36	45,67
39	37,830	9,476	89	86,330	21,626	139	134,83	33,77	189	183,33	45,92
40	38,800	9,719	90	87,300	21,869	140	135,80	34,01	190	184,30	46,16
41	39,770	9,962	91	88,270	22,112	141	136,77	34,25	191	185,27	46,40
42	40,740	10,205	92	89,240	22,355	142	137,74	34,49	192	186,24	46,64
43	41,710	10,448	93	90,210	22,598	143	138,71	34,74	193	187,21	46,89
44	42,680	10,691	94	91,180	22,841	144	139,68	34,98	194	188,18	47,13
45	43,650	10,934	95	92,150	23,084	145	140,65	35,22	195	189,15	47,37
46	44,620	11,177	96	93,130	23,327	146	141,62	35,47	196	190,12	47,62
47	45,590	11,420	97	94,090	23,570	147	142,59	35,71	197	191,09	47,86
48	46,560	11,663	98	95,060	23,813	148	143,56	35,95	198	192,06	48,10
49	47,530	11,906	99	96,030	24,056	149	144,53	36,20	199	193,03	48,35
50	48,500	12,149	100	97,000	24,299	150	145,50	36,44	200	194,08	48,60
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Six $\frac{1}{4}$ Points. E. N. E. $\frac{3}{4}$ E. E. S. E. $\frac{3}{4}$ E. W. N. W. $\frac{3}{4}$ W. W. S. W. $\frac{3}{4}$ W.

Traverse Table for 1 $\frac{1}{2}$ Point. N. b E. $\frac{1}{2}$ E. N. b W. $\frac{1}{2}$ W. S. b E. $\frac{1}{2}$ E. S. b W. $\frac{1}{2}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,957	0,290	51	48,802	14,805	101	96,65	29,32	151	144,49	43,84
2	1,914	0,581	52	49,759	15,096	102	97,60	29,61	152	145,45	44,13
3	2,871	0,871	53	50,716	15,386	103	98,56	29,90	153	146,41	44,42
4	3,828	1,161	54	51,673	15,676	104	99,52	30,19	154	147,36	44,71
5	4,785	1,451	55	52,629	15,966	105	100,47	30,48	155	148,32	45,00
6	5,742	1,742	56	53,586	16,257	106	101,43	30,77	156	149,28	45,29
7	6,699	2,032	57	54,543	16,547	107	102,39	31,06	157	150,23	45,58
8	7,655	2,322	58	55,500	16,837	108	103,35	31,35	158	151,19	45,87
9	8,612	2,613	59	56,457	17,128	109	104,30	31,64	159	152,15	46,16
10	9,569	2,903	60	57,414	17,418	110	105,26	31,93	160	153,10	46,45
11	10,526	3,193	61	58,371	17,708	111	106,22	32,22	161	154,06	46,74
12	11,483	3,484	62	59,328	17,999	112	107,17	32,51	162	155,02	47,03
13	12,440	3,774	63	60,285	18,289	113	108,13	32,80	163	155,97	47,32
14	13,397	4,064	64	61,242	18,579	114	109,09	33,09	164	156,93	47,61
15	14,353	4,354	65	62,198	18,869	115	110,04	33,38	165	157,89	47,90
16	15,310	4,645	66	63,155	19,160	116	111,00	33,67	166	158,85	48,19
17	16,267	4,935	67	64,112	19,450	117	111,96	33,96	167	159,80	48,48
18	17,224	5,225	68	65,069	19,740	118	112,91	34,26	168	160,76	48,77
19	18,181	5,516	69	66,026	20,031	119	113,87	34,55	169	161,72	49,06
20	19,138	5,806	70	66,983	20,321	120	114,83	34,84	170	162,67	49,35
21	20,095	6,096	71	67,940	20,611	121	115,78	35,13	171	163,63	49,64
22	21,052	6,387	72	68,897	20,902	122	116,74	35,42	172	164,59	49,93
23	22,009	6,677	73	69,854	21,192	123	117,70	35,71	173	165,54	50,22
24	22,966	6,967	74	70,811	21,482	124	118,66	36,00	174	166,50	50,51
25	23,922	7,257	75	71,767	21,772	125	119,61	36,29	175	167,46	50,80
26	24,879	7,548	76	72,724	22,063	126	120,57	36,58	176	168,41	51,09
27	25,836	7,838	77	73,681	22,353	127	121,53	36,87	177	169,37	51,38
28	26,793	8,128	78	74,638	22,643	128	122,48	37,16	178	170,33	51,67
29	27,750	8,419	79	75,595	22,934	129	123,44	37,45	179	171,28	51,96
30	28,707	8,709	80	76,552	23,224	130	124,40	37,74	180	172,24	52,25
31	29,664	8,999	81	77,509	23,514	131	125,35	38,03	181	173,20	52,54
32	30,621	9,290	82	78,466	23,805	132	126,31	38,32	182	174,16	52,83
33	31,578	9,580	83	79,423	24,095	133	127,27	38,61	183	175,11	53,12
34	32,535	9,870	84	80,380	24,385	134	128,22	38,90	184	176,07	53,42
35	33,491	10,160	85	81,336	24,675	135	129,18	39,19	185	177,03	53,71
36	34,448	10,451	86	82,293	24,966	136	130,14	39,48	186	177,98	54,00
37	35,405	10,741	87	83,250	25,256	137	131,09	39,77	187	178,94	54,29
38	36,362	11,031	88	84,207	25,546	138	132,05	40,06	188	179,90	54,58
39	37,319	11,322	89	85,164	25,837	139	133,01	40,35	189	180,85	54,87
40	38,276	11,612	90	86,121	26,127	140	133,97	40,64	190	181,81	55,16
41	39,233	11,902	91	87,078	26,417	141	134,92	40,93	191	182,77	55,45
42	40,190	12,193	92	88,035	26,708	142	135,88	41,22	192	183,72	55,74
43	41,148	12,483	93	88,992	26,998	143	136,84	41,51	193	184,68	56,03
44	42,104	12,773	94	89,949	27,288	144	137,79	41,80	194	185,64	56,32
45	43,060	13,063	95	90,905	27,575	145	138,75	42,09	195	186,60	56,61
46	44,017	13,354	96	91,862	27,869	146	139,71	42,38	196	187,55	56,90
47	44,974	13,644	97	92,819	28,159	147	140,66	42,67	197	188,51	57,19
48	45,931	13,934	98	93,776	28,449	148	141,62	42,96	198	189,47	57,48
49	46,888	14,225	99	94,733	28,740	149	142,58	43,25	199	190,42	57,77
50	47,845	14,515	100	95,690	29,030	150	143,53	43,54	200	191,38	58,06
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

6 $\frac{1}{2}$ Points. E. N. E. $\frac{1}{2}$ E. E. S. E. $\frac{1}{2}$ E. W. N. W. $\frac{1}{2}$ W. W. S. W. $\frac{1}{2}$ W.

Traverse Table for $1\frac{1}{4}$ Point. N. b E. $\frac{1}{4}$ E. N. b W. $\frac{1}{4}$ W. S. b E. $\frac{1}{4}$ E. S. b W. $\frac{1}{4}$ W.

Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.	Diff.	D. Lat.	Dep.
1	0,941	0,337	51	48,016	17,182	101	95,09	34,03	151	142,17	50,87
2	1,883	0,674	52	48,958	17,519	102	96,83	34,30	152	143,11	51,21
3	2,825	1,011	53	49,899	17,856	103	96,97	34,70	153	144,05	51,55
4	3,766	1,348	54	50,841	18,193	104	97,92	35,04	154	144,99	51,88
5	4,708	1,684	55	51,782	18,529	105	98,86	35,37	155	145,93	52,22
6	5,649	2,021	56	52,724	18,866	106	99,80	35,71	156	146,87	52,56
7	6,591	2,358	57	53,665	19,203	107	100,74	36,05	157	147,82	52,89
8	7,532	2,695	58	54,607	19,540	108	101,68	36,39	158	148,76	53,23
9	8,474	3,032	59	55,548	19,877	109	102,62	36,72	159	149,70	53,57
10	9,415	3,369	60	56,490	20,214	110	103,56	37,06	160	150,64	53,90
11	10,356	3,706	61	57,431	20,551	111	104,51	37,40	161	151,58	54,24
12	11,298	4,023	62	58,373	20,888	112	105,45	37,73	162	152,52	54,58
13	12,239	4,380	63	59,314	21,225	113	106,39	38,07	163	153,46	54,91
14	13,181	4,717	64	60,256	21,562	114	107,33	38,41	164	154,41	55,25
15	14,122	5,053	65	61,197	21,898	115	108,27	38,74	165	155,35	55,59
16	15,064	5,390	66	62,139	22,235	116	109,21	39,08	166	156,29	55,93
17	16,005	5,727	67	63,080	22,572	117	110,16	39,42	167	157,23	56,26
18	16,947	6,064	68	64,022	22,909	118	111,10	39,75	168	158,17	56,60
19	17,888	6,401	69	64,963	23,246	119	112,04	40,09	169	159,11	56,94
20	18,830	6,738	70	65,905	23,583	120	112,98	40,43	170	160,05	57,27
21	19,771	7,073	71	66,846	23,920	121	113,92	40,76	171	161,00	57,61
22	20,713	7,412	72	67,788	24,257	122	114,86	41,10	172	161,94	57,96
23	21,654	7,749	73	68,729	24,594	123	115,80	41,44	173	162,88	58,28
24	22,596	8,086	74	69,671	24,931	124	116,75	41,78	174	163,82	58,62
25	23,537	8,422	75	70,612	25,267	125	117,69	42,11	175	164,76	58,96
26	24,479	8,759	76	71,554	25,604	126	118,63	42,45	176	165,70	59,29
27	25,420	9,096	77	72,495	25,941	127	119,57	42,79	177	166,65	59,63
28	26,362	9,433	78	73,437	26,278	128	120,51	43,12	178	167,59	59,97
29	27,303	9,770	79	74,378	26,615	129	121,45	43,46	179	168,53	60,31
30	28,245	10,107	80	75,320	26,952	130	122,39	43,80	180	169,47	60,64
31	29,186	10,444	81	76,261	27,289	131	123,34	44,13	181	170,41	60,98
32	30,128	10,781	82	77,203	27,626	132	124,28	44,47	182	171,35	61,32
33	31,069	11,118	83	78,144	27,963	133	125,22	44,81	183	172,29	61,65
34	32,011	11,455	84	79,086	28,300	134	126,16	45,14	184	173,24	61,99
35	32,952	11,791	85	80,027	28,636	135	127,10	45,48	185	174,18	62,33
36	33,894	12,128	86	80,969	28,973	136	128,04	45,82	186	175,12	62,66
37	34,835	12,465	87	81,910	29,310	137	128,99	46,16	187	176,06	63,00
38	35,777	12,802	88	82,852	29,647	138	129,93	46,49	188	177,00	63,34
39	36,718	13,139	89	83,793	29,984	139	130,87	46,83	189	177,94	63,67
40	37,660	13,476	90	84,735	30,321	140	131,81	47,17	190	178,88	64,01
41	38,601	13,813	91	85,676	30,658	141	132,75	47,50	191	179,83	64,35
42	39,543	14,150	92	86,618	30,995	142	133,69	47,84	192	180,77	64,68
43	40,485	14,487	93	87,559	31,332	143	134,63	48,18	193	181,71	65,02
44	41,427	14,827	94	88,501	31,669	144	135,58	48,51	194	182,65	65,36
45	42,368	15,160	95	89,442	32,005	145	136,52	48,85	195	183,59	65,70
46	43,310	15,497	96	90,384	32,342	146	137,46	49,19	196	184,53	66,03
47	44,251	15,834	97	91,325	32,679	147	138,40	49,52	197	185,48	66,37
48	45,193	16,171	98	92,267	33,016	148	139,34	49,86	198	186,42	66,71
49	46,134	16,508	99	93,208	33,353	149	140,28	50,20	199	187,36	67,04
50	47,075	16,844	100	94,150	33,690	150	141,22	50,53	200	188,30	67,38
Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.

Six $\frac{1}{4}$ Points. E. N. E. $\frac{1}{4}$ E. E. S. E. $\frac{1}{4}$ E. W. N. W. $\frac{1}{4}$ W. W. S. W. $\frac{1}{4}$ W.

Traverse Table for 2 Points. N. N. E. N. N. W. S. S. E. S. S. W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,924	0,383	51	47,119	19,518	101	93,31	38,65	151	139,51	57,79
2	1,848	0,765	52	48,043	19,900	102	94,24	39,03	152	140,43	58,17
3	2,772	1,148	53	48,967	20,283	103	95,16	39,42	153	141,36	58,55
4	3,695	1,530	54	49,891	20,666	104	96,09	39,80	154	142,28	58,94
5	4,619	1,913	55	50,814	21,048	105	97,01	40,18	155	143,20	59,32
6	5,543	2,296	56	51,738	21,431	106	97,93	40,56	156	144,13	59,70
7	6,464	2,679	57	52,662	21,814	107	98,86	40,95	157	145,05	60,08
8	7,391	3,061	58	53,586	22,197	108	99,78	41,33	158	145,98	60,47
9	8,315	3,444	59	54,510	22,579	109	100,71	41,71	159	146,90	60,85
10	9,239	3,827	60	55,434	22,962	110	101,63	42,10	160	147,82	61,23
11	10,163	4,210	61	56,358	23,345	111	102,55	42,48	161	148,75	61,61
12	11,087	4,592	62	57,282	23,727	112	103,48	42,86	162	149,67	62,00
13	12,011	4,975	63	58,206	24,110	113	104,40	43,24	163	150,60	62,38
14	12,935	5,358	64	59,130	24,493	114	105,32	43,63	164	151,52	62,76
15	13,858	5,740	65	60,053	24,875	115	106,25	44,01	165	152,44	63,15
16	14,782	6,123	66	60,977	25,258	116	107,17	44,39	166	153,37	63,53
17	15,706	6,506	67	61,901	25,641	117	108,10	44,77	167	154,29	63,91
18	16,630	6,889	68	62,825	26,022	118	109,02	45,16	168	155,21	64,29
19	17,554	7,271	69	63,749	26,406	119	109,94	45,54	169	156,14	64,68
20	18,478	7,654	70	64,673	26,789	120	110,87	45,92	170	157,06	65,06
21	19,406	8,037	71	65,597	27,172	121	111,79	46,31	171	157,99	65,44
22	20,322	8,419	72	66,521	27,554	122	112,72	46,69	172	158,91	65,82
23	21,250	8,802	73	67,445	27,937	123	113,64	47,07	173	159,83	66,21
24	22,174	9,185	74	68,369	28,320	124	114,56	47,45	174	160,76	66,59
25	23,097	9,567	75	69,292	28,702	125	115,49	47,84	175	161,68	66,97
26	24,021	9,950	76	70,216	29,085	126	116,41	48,22	176	162,61	67,36
27	24,945	10,333	77	71,140	29,468	127	117,34	48,60	177	163,53	67,74
28	25,869	10,716	78	72,064	29,851	128	118,26	48,98	178	164,45	68,12
29	26,793	11,098	79	72,988	30,233	129	119,18	49,37	179	165,38	68,50
30	27,717	11,481	80	73,912	30,616	130	120,11	49,75	180	166,30	68,89
31	28,640	11,864	81	74,836	30,999	131	121,03	50,13	181	167,23	69,27
32	29,565	12,246	82	75,760	31,381	132	121,95	50,52	182	168,15	69,65
33	30,489	12,629	83	76,684	31,764	133	122,88	50,90	183	169,07	70,03
34	31,413	13,012	84	77,608	32,147	134	123,80	51,28	184	170,00	70,42
35	32,336	13,394	85	78,531	32,529	135	124,73	51,66	185	170,92	70,80
36	33,260	13,777	86	79,455	32,912	136	125,65	52,05	186	171,85	71,18
37	34,184	14,160	87	80,379	33,295	137	126,57	52,43	187	172,77	71,56
38	35,108	14,543	88	81,303	33,678	138	127,50	52,81	188	173,69	71,95
39	36,032	14,925	89	82,227	34,060	139	128,42	53,19	189	174,62	72,33
40	36,956	15,308	90	83,151	34,443	140	129,35	53,58	190	175,54	72,71
41	37,880	15,691	91	84,075	34,826	141	130,27	53,96	191	176,46	73,10
42	38,804	16,073	92	84,999	35,208	142	131,19	54,34	192	177,39	73,48
43	39,728	16,456	93	85,923	35,591	143	132,12	54,72	193	178,31	73,86
44	40,652	16,839	94	86,847	35,974	144	133,04	55,11	194	179,24	74,24
45	41,575	17,221	95	87,770	36,356	145	133,97	55,49	195	180,16	74,63
46	42,499	17,604	96	88,694	36,738	146	134,89	55,87	196	181,08	75,01
47	43,423	17,989	97	89,618	37,121	147	135,81	56,26	197	182,01	75,39
48	44,347	18,370	98	90,542	37,504	148	136,74	56,64	198	182,93	75,77
49	45,271	18,752	99	91,466	37,886	149	137,66	57,02	199	183,86	76,16
50	46,195	19,135	100	92,390	38,269	150	138,58	57,40	200	184,78	76,54
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

6 Points, E. N. E. W. N. W. E. S. E. W. S. W.

Traverse Table for 2 $\frac{1}{4}$ Points. N. N. E. $\frac{1}{4}$ E. N. N. W. $\frac{1}{4}$ W. S. S. E. $\frac{1}{4}$ E. S. S. W. $\frac{1}{4}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,904	0,428	51	46,104	21,808	101	91,30	43,19	151	136,50	64,57
2	1,808	0,855	52	47,008	22,235	102	92,21	43,61	152	137,41	65,00
3	2,712	1,283	53	47,912	22,663	103	93,11	44,04	153	138,31	65,42
4	3,616	1,710	54	48,816	23,090	104	94,02	44,47	154	139,22	65,85
5	4,520	2,138	55	49,720	23,518	105	94,92	44,90	155	140,12	66,28
6	5,424	2,565	56	50,624	23,946	106	95,82	45,33	156	141,02	66,71
7	6,328	2,993	57	51,528	24,373	107	96,73	45,75	157	141,93	67,13
8	7,232	3,420	58	52,432	24,801	108	97,63	46,18	158	142,83	67,56
9	8,136	3,848	59	53,336	25,228	109	98,54	46,61	159	143,74	67,99
10	9,040	4,276	60	54,240	25,656	110	99,44	47,04	160	144,64	68,42
11	9,944	4,704	61	55,144	26,084	111	100,34	47,46	161	145,54	68,84
12	10,848	5,131	62	56,048	26,511	112	101,25	47,89	162	146,45	69,27
13	11,752	5,559	63	56,952	26,939	113	102,15	48,32	163	147,35	69,70
14	12,656	5,986	64	57,856	27,366	114	103,05	48,75	164	148,26	70,13
15	13,560	6,414	65	58,760	27,794	115	103,96	49,17	165	149,16	70,55
16	14,464	6,842	66	59,664	28,222	116	104,86	49,60	166	150,06	70,98
17	15,368	7,269	67	60,568	28,649	117	105,77	50,03	167	150,97	71,41
18	16,272	7,697	68	61,472	29,077	118	106,67	50,46	168	151,87	71,83
19	17,176	8,124	69	62,376	29,504	119	107,58	50,88	169	152,78	72,26
20	18,080	8,552	70	63,280	29,932	120	108,48	51,31	170	153,68	72,69
21	18,984	8,980	71	64,184	30,360	121	109,38	51,74	171	154,58	73,12
22	19,888	9,407	72	65,088	30,787	122	110,29	52,17	172	155,49	73,55
23	20,792	9,835	73	65,992	31,215	123	111,19	52,59	173	156,39	73,97
24	21,696	10,262	74	66,896	31,642	124	112,10	53,02	174	157,30	74,40
25	22,600	10,690	75	67,800	32,070	125	113,00	53,45	175	158,20	74,83
26	23,504	11,118	76	68,704	32,498	126	113,90	53,88	176	159,10	75,26
27	24,408	11,545	77	69,608	32,925	127	114,81	54,31	177	160,01	75,68
28	25,312	11,973	78	70,512	33,353	128	115,71	54,73	178	160,91	76,11
29	26,216	12,400	79	71,416	33,780	129	116,62	55,16	179	161,82	76,54
30	27,120	12,828	80	72,320	34,208	130	117,52	55,59	180	162,72	76,97
31	28,024	13,256	81	73,224	34,636	131	118,42	56,02	181	163,62	77,40
32	28,928	13,683	82	74,128	35,063	132	119,33	56,44	182	164,53	77,82
33	29,832	14,111	83	75,032	35,491	133	120,23	56,87	183	165,43	78,25
34	30,736	14,538	84	75,936	35,918	134	121,14	57,30	184	166,34	78,68
35	31,640	14,966	85	76,840	36,346	135	122,04	57,73	185	167,24	79,11
36	32,544	15,394	86	77,744	36,774	136	122,94	58,15	186	168,14	79,53
37	33,448	15,821	87	78,648	37,201	137	123,85	58,58	187	169,05	79,96
38	34,352	16,249	88	79,552	37,629	138	124,75	59,01	188	169,95	80,39
39	35,256	16,676	89	80,456	38,056	139	125,66	59,44	189	170,86	80,82
40	36,160	17,104	90	81,360	38,484	140	126,56	59,86	190	171,76	81,24
41	37,064	17,532	91	82,264	38,912	141	127,46	60,29	191	172,66	81,67
42	37,968	17,959	92	83,168	39,339	142	128,37	60,72	192	173,57	82,10
43	38,872	18,387	93	84,072	39,767	143	129,27	61,15	193	174,47	82,53
44	39,776	18,814	94	84,976	40,194	144	130,18	61,57	194	175,38	82,95
45	40,680	19,242	95	85,880	40,622	145	131,08	62,00	195	176,28	83,38
46	41,584	19,670	96	86,784	41,050	146	131,98	62,43	196	177,18	83,81
47	42,488	20,097	97	87,688	41,477	147	132,89	62,86	197	178,09	84,23
48	43,392	20,525	98	88,592	41,905	148	133,79	63,28	198	178,99	84,66
49	44,296	20,952	99	89,496	42,332	149	134,70	63,71	199	179,90	85,09
50	45,200	21,380	100	90,400	42,760	150	135,60	64,14	200	180,80	85,52
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Five $\frac{1}{4}$ Points. N. E. b E. $\frac{3}{4}$ E. N. W. b W. $\frac{3}{4}$ W. S. E. b E. $\frac{3}{4}$ E. S. W. b W. $\frac{3}{4}$ W.

Traverse Table for $2\frac{1}{2}$ Points. N. N. E. $\frac{1}{2}$ E. N. N. W. $\frac{1}{2}$ W. S. S. E. $\frac{1}{2}$ E. S. S. W. $\frac{1}{2}$ W.

Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.
1	0,882	0,471	51	44,977	24,041	101	89,07	47,61	151	133,17	71,18
2	1,764	0,943	52	45,859	24,513	102	89,95	48,08	152	134,05	71,65
3	2,646	1,414	53	46,741	24,984	103	90,84	48,55	153	134,93	72,12
4	3,528	1,886	54	47,623	25,456	104	91,72	49,03	154	135,81	72,60
5	4,410	2,357	55	48,504	25,927	105	92,60	49,50	155	136,69	73,07
6	5,291	2,828	56	49,386	26,398	106	93,48	49,97	156	137,58	73,54
7	6,173	3,300	57	50,268	26,870	107	94,36	50,44	157	138,46	74,01
8	7,055	3,771	58	51,150	27,341	108	95,24	50,91	158	139,34	74,48
9	7,937	4,243	59	52,032	27,813	109	96,13	51,38	159	140,22	74,95
10	8,819	4,714	60	52,914	28,284	110	97,01	51,85	160	141,10	75,42
11	9,701	5,185	61	53,796	28,755	111	97,89	52,33	161	141,99	75,90
12	10,583	5,657	62	54,678	29,227	112	98,77	52,80	162	142,87	76,37
13	11,465	6,128	63	55,560	29,698	113	99,65	53,27	163	143,75	76,84
14	12,347	6,600	64	56,442	30,170	114	100,54	53,74	164	144,36	77,31
15	13,228	7,071	65	57,323	30,641	115	101,42	54,21	165	145,51	77,78
16	14,110	7,542	66	58,205	31,112	116	102,30	54,68	166	146,40	78,25
17	14,992	8,014	67	59,087	31,584	117	103,18	55,15	167	147,28	78,72
18	15,874	8,485	68	59,969	32,055	118	104,06	55,62	168	148,16	79,19
19	16,756	8,957	69	60,851	32,527	119	104,95	56,10	169	149,04	79,67
20	17,638	9,428	70	61,733	32,998	120	105,83	56,57	170	149,92	80,14
21	18,520	9,899	71	62,615	33,469	121	106,71	57,04	171	150,80	80,61
22	19,402	10,371	72	63,497	33,941	122	107,59	57,51	172	151,69	81,08
23	20,284	10,842	73	64,379	34,412	123	108,47	57,98	173	152,57	81,55
24	21,166	11,314	74	65,261	34,884	124	109,36	58,45	174	153,45	82,02
25	22,047	11,785	75	66,142	35,355	125	110,24	58,92	175	154,33	82,49
26	22,929	12,256	76	67,024	35,826	126	111,12	59,40	176	155,21	83,97
27	23,811	12,728	77	67,906	36,298	127	112,00	59,87	177	156,10	83,44
28	24,692	13,199	78	68,788	36,769	128	112,88	60,34	178	156,98	83,91
29	25,575	13,671	79	69,670	37,241	129	113,76	60,81	179	157,86	84,38
30	26,457	14,142	80	70,552	37,712	130	114,65	61,28	180	158,74	84,85
31	27,339	14,613	81	71,434	38,183	131	115,53	61,75	181	159,62	85,32
32	28,221	15,085	82	72,316	38,655	132	116,41	62,22	182	160,51	85,79
33	29,103	15,556	83	73,198	39,126	133	117,29	62,70	183	161,39	86,27
34	29,985	16,028	84	74,080	39,598	134	118,17	63,17	184	162,27	86,74
35	30,866	16,499	85	74,961	40,069	135	119,06	63,64	185	163,15	87,21
36	31,748	16,970	86	75,843	40,540	136	119,94	64,11	186	164,03	87,68
37	32,630	17,442	87	76,725	41,012	137	120,82	64,58	187	164,91	88,15
38	33,512	17,913	88	77,607	41,483	138	121,70	65,05	188	165,80	88,62
39	34,394	18,385	89	78,489	41,955	139	122,58	65,22	189	166,68	89,09
40	35,276	18,856	90	79,371	42,426	140	123,47	66,00	190	167,56	89,57
41	36,158	19,327	91	80,253	42,897	141	124,35	66,47	191	168,44	90,04
42	37,040	19,799	92	81,135	43,369	142	125,23	66,94	192	169,32	90,51
43	37,922	20,270	93	82,017	43,840	143	126,11	67,41	193	170,21	90,98
44	38,804	20,742	94	82,899	44,312	144	126,99	67,88	194	171,09	91,45
45	39,685	21,213	95	83,780	44,783	145	127,88	68,35	195	171,97	91,92
46	40,567	21,684	96	84,662	45,254	146	128,76	68,82	196	172,85	92,39
47	41,449	22,156	97	85,544	45,726	147	129,64	69,30	197	173,73	92,87
48	42,331	22,627	98	86,426	46,197	148	130,52	69,77	198	174,62	93,34
49	43,213	23,099	99	87,308	46,669	149	131,40	70,24	199	175,50	93,81
50	44,095	23,570	100	88,190	47,140	150	132,28	70,71	200	176,38	94,28
Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.

Five $\frac{1}{2}$ Points. N. E. b E. $\frac{1}{2}$ E. N. W. b W. $\frac{1}{2}$ W. S. E. b E. $\frac{1}{2}$ E. S. W. b W. $\frac{1}{2}$ W.

Traverse Table for 2 $\frac{1}{4}$ Point. N. N. E. $\frac{3}{4}$ E. N. N. W. $\frac{3}{4}$ W. S. S. E. $\frac{3}{4}$ E. S. S. W. $\frac{3}{4}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,858	0,514	51	43,743	26,219	101	86,63	51,92	151	129,51	77,63
2	1,715	1,028	52	44,600	26,723	102	87,49	52,44	152	130,37	78,14
3	2,573	1,542	53	45,458	27,247	103	88,34	52,95	153	131,23	78,66
4	3,431	2,056	54	46,316	27,761	104	89,20	53,47	154	132,08	79,17
5	4,289	2,570	55	47,173	28,275	105	90,06	53,98	155	132,94	79,68
6	5,146	3,085	56	48,031	28,790	106	90,92	54,49	156	133,80	80,20
7	6,004	3,599	57	48,889	29,304	107	91,77	55,01	157	134,66	80,71
8	6,862	4,113	58	49,747	29,818	108	92,63	55,52	158	135,52	81,23
9	7,720	4,627	59	50,604	30,332	109	93,49	56,04	159	136,37	81,74
10	8,577	5,141	60	51,462	30,846	110	94,35	56,55	160	137,23	82,26
11	9,435	5,655	61	52,320	31,360	111	95,20	57,06	161	138,09	82,77
12	10,292	6,169	62	53,177	31,874	112	96,06	57,58	162	138,95	83,28
13	11,150	6,683	63	54,035	32,388	113	96,92	58,09	163	139,80	83,80
14	12,008	7,197	64	54,893	32,902	114	97,78	58,61	164	140,66	84,31
15	12,865	7,711	65	55,750	33,416	115	98,64	59,12	165	141,52	84,83
16	13,723	8,226	66	56,608	33,931	116	99,49	59,64	166	142,38	85,35
17	14,581	8,740	67	57,466	34,445	117	100,35	60,15	167	143,24	85,85
18	15,439	9,254	68	58,324	34,958	118	101,21	60,66	168	144,09	86,37
19	16,296	9,768	69	59,181	35,473	119	102,07	61,18	169	144,95	86,88
20	17,154	10,282	70	60,039	35,987	120	102,92	61,69	170	145,81	87,40
21	18,012	10,796	71	60,897	36,501	121	103,78	62,21	171	146,67	87,91
22	18,869	11,310	72	61,754	37,015	122	104,64	62,72	172	147,52	88,42
23	19,727	11,824	73	62,612	37,529	123	105,50	63,23	173	148,38	88,94
24	20,585	12,338	74	63,470	38,043	124	106,35	63,75	174	149,24	89,45
25	21,442	12,852	75	64,327	38,557	125	107,21	64,26	175	150,10	89,95
26	22,300	13,367	76	65,185	39,071	126	108,07	64,78	176	150,96	90,48
27	23,158	13,881	77	66,043	39,586	127	108,93	65,29	177	151,81	91,00
28	24,016	14,395	78	66,901	40,100	128	109,79	65,80	178	152,67	91,51
29	24,873	14,903	79	67,758	40,614	129	110,64	66,32	179	153,53	92,02
30	25,731	15,423	80	68,616	41,128	130	111,50	66,83	180	154,39	92,54
31	26,589	15,937	81	69,474	41,642	131	112,36	67,35	181	155,24	93,05
32	27,446	16,451	82	70,331	42,156	132	113,22	67,86	182	156,10	93,57
33	28,304	16,968	83	71,189	42,670	133	114,07	68,37	183	156,96	94,08
34	29,162	17,479	84	72,047	43,184	134	114,93	68,89	184	157,82	94,59
35	30,019	17,993	85	72,904	43,698	135	115,79	69,40	185	158,67	95,11
36	30,877	18,508	86	73,762	44,213	136	116,65	69,92	186	159,53	95,62
37	31,735	19,022	87	74,620	44,727	137	117,50	70,43	187	160,39	96,14
38	32,593	19,536	88	75,478	45,241	138	118,36	70,95	188	161,25	96,65
39	33,450	20,050	89	76,335	45,755	139	119,22	71,46	189	162,11	97,16
40	34,308	20,564	90	77,193	46,269	140	120,08	71,97	190	162,96	97,68
41	35,166	21,078	91	78,051	46,783	141	120,94	72,49	191	163,82	98,19
42	36,023	21,592	92	78,908	47,297	142	121,79	73,00	192	164,68	98,71
43	36,881	22,107	93	79,766	47,811	143	122,65	73,52	193	165,54	99,22
44	37,739	22,621	94	80,624	48,325	144	123,51	74,03	194	166,39	99,74
45	38,596	23,135	95	81,481	48,839	145	124,37	74,54	195	167,25	100,25
46	39,454	23,650	96	82,339	49,354	146	125,22	75,06	196	168,11	100,76
47	40,312	24,164	97	83,197	49,868	147	126,08	75,57	197	168,97	101,28
48	41,170	24,678	98	84,055	50,382	148	126,94	76,09	198	169,82	101,79
49	42,027	25,192	99	84,912	50,896	149	127,80	76,60	199	170,68	102,31
50	42,885	25,705	100	85,770	51,410	150	128,65	77,11	200	171,54	102,82
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Five $\frac{1}{4}$ Points. N. E. bE. $\frac{1}{4}$ E. N. W. bW. $\frac{1}{4}$ W. S. E. bE. $\frac{1}{4}$ E. S. W. bW. $\frac{1}{4}$ W.

Traverse Table for 3 Points. N. E. b N. N. W. N. S. E. b S. S. W. b S.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,831	0,555	51	42,406	28,336	101	83,98	56,12	151	125,56	83,90
2	1,663	1,111	52	43,238	28,891	102	84,81	56,67	152	126,39	84,45
3	2,494	1,667	53	44,069	29,447	103	85,64	57,23	153	127,22	85,01
4	3,326	2,222	54	44,901	30,002	104	86,48	57,78	154	128,05	85,56
5	4,157	2,778	55	45,732	30,558	105	87,31	58,34	155	128,88	86,12
6	4,989	3,333	56	46,564	31,114	106	88,14	58,89	156	129,71	86,67
7	5,820	3,889	57	47,395	31,669	107	88,97	59,45	157	130,55	87,23
8	6,652	4,445	58	48,227	32,225	108	89,80	60,00	158	131,38	87,78
9	7,483	5,000	59	49,058	32,780	109	90,63	60,56	159	132,21	88,34
10	8,315	5,556	60	49,890	33,336	110	91,46	61,12	160	133,04	88,90
11	9,146	6,112	61	50,721	33,892	111	92,30	61,67	161	133,87	89,45
12	9,978	6,667	62	51,553	34,447	112	93,13	62,23	162	134,70	90,01
13	10,809	7,223	63	52,384	35,003	113	93,96	62,78	163	135,53	90,56
14	11,641	7,778	64	53,216	35,558	114	94,79	63,34	164	136,37	91,12
15	12,472	8,334	65	54,047	36,114	115	95,62	63,89	165	137,20	91,67
16	13,304	8,890	66	54,879	36,670	116	96,45	64,45	166	138,03	92,23
17	14,135	9,445	67	55,710	37,225	117	97,29	65,00	167	138,86	92,78
18	14,967	10,001	68	56,542	37,781	118	98,12	65,56	168	139,69	93,34
19	15,798	10,556	69	57,373	38,336	119	98,95	66,12	169	140,52	93,90
20	16,630	11,112	70	58,205	38,892	120	99,78	66,67	170	141,35	94,45
21	17,461	11,668	71	59,036	39,448	121	100,61	67,23	171	142,19	95,01
22	18,293	12,223	72	59,868	40,003	122	101,44	67,78	172	143,02	95,56
23	19,124	12,779	73	60,699	40,559	123	102,27	68,34	173	143,85	96,12
24	19,956	13,334	74	61,531	41,114	124	103,11	68,89	174	144,68	96,67
25	20,787	13,890	75	62,362	41,670	125	103,94	69,45	175	145,51	97,23
26	21,619	14,446	76	63,194	42,226	126	104,77	70,01	176	146,34	97,79
27	22,450	15,001	77	64,025	42,781	127	105,60	70,56	177	147,18	98,34
28	23,282	15,557	78	64,857	43,337	128	106,43	71,12	178	148,01	98,90
29	24,113	16,112	79	65,688	43,892	129	107,26	71,67	179	148,84	99,45
30	24,945	16,668	80	66,520	44,448	130	108,09	72,23	180	149,67	100,01
31	25,776	17,224	81	67,351	45,004	131	108,93	72,78	181	150,50	100,56
32	26,608	17,779	82	68,183	45,559	132	109,76	73,34	182	151,33	101,12
33	27,439	18,335	83	69,014	46,115	133	110,59	73,89	183	152,16	101,67
34	28,271	18,890	84	69,846	46,670	134	111,42	74,45	184	153,00	102,23
35	29,102	19,446	85	70,677	47,226	135	112,25	75,01	185	153,83	102,79
36	29,934	20,002	86	71,509	47,782	136	113,08	75,56	186	154,66	103,34
37	30,765	20,557	87	72,340	48,337	137	113,92	76,12	187	155,49	103,90
38	31,597	21,113	88	73,172	48,893	138	114,75	76,67	188	156,32	104,45
39	32,428	21,668	89	74,003	49,448	139	115,58	77,23	189	157,15	105,01
40	33,259	22,224	90	74,835	50,004	140	116,41	77,78	190	157,98	105,56
41	34,091	22,780	91	75,666	50,560	141	117,24	78,34	191	158,82	106,12
42	34,923	23,335	92	76,498	51,115	142	118,07	78,89	192	159,65	106,67
43	35,754	23,891	93	77,329	51,671	143	118,90	79,45	193	160,48	107,23
44	36,586	24,446	94	78,161	52,226	144	119,74	80,01	194	161,31	107,79
45	37,417	25,002	95	78,992	52,782	145	120,57	80,56	195	162,14	108,34
46	38,249	25,558	96	79,824	53,338	146	121,40	81,12	196	162,97	108,90
47	39,080	26,113	97	80,655	53,893	147	122,23	81,67	197	163,81	109,45
48	39,912	26,669	98	81,487	54,449	148	123,06	82,23	198	164,64	110,01
49	40,743	27,224	99	82,318	55,004	149	123,89	82,78	199	165,47	110,56
50	41,573	27,780	100	83,150	55,560	150	124,72	83,34	200	166,30	111,12
Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.	Diff.	Dep.	D. Lat.

Five Points. N. E. b E. N. W. b W. S. E. b E. S. W. b W.

Traverse Table for 3 $\frac{1}{2}$ Points. N.E. b N. $\frac{1}{2}$ E. N.W. b N. $\frac{1}{2}$ W. S.E. b S. $\frac{1}{2}$ E. S.W. b S. $\frac{1}{2}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,803	0,596	51	40,963	30,381	101	81,12	60,17	151	121,28	89,95
2	1,606	1,191	52	41,766	30,976	102	81,93	60,76	152	122,09	90,55
3	2,410	1,787	53	42,570	31,572	103	82,73	61,36	153	122,89	91,14
4	3,213	2,383	54	43,373	32,168	104	83,53	61,95	154	123,69	91,74
5	4,016	2,978	55	44,176	32,763	105	84,34	62,55	155	124,50	92,33
6	4,819	3,574	56	44,979	33,359	106	85,14	63,14	156	125,30	92,93
7	5,622	4,170	57	45,782	33,955	107	85,94	63,74	157	126,10	93,52
8	6,426	4,766	58	46,586	34,551	108	86,75	64,34	158	126,91	94,12
9	7,229	5,361	59	47,389	35,146	109	87,55	64,93	159	127,71	94,72
10	8,032	5,957	60	48,192	35,742	110	88,35	65,53	160	128,51	95,31
11	8,835	6,553	61	48,995	36,338	111	89,15	66,12	161	129,31	95,91
12	9,638	7,148	62	49,798	36,933	112	89,96	66,72	162	130,12	96,50
13	10,442	7,744	63	50,602	37,529	113	90,76	67,31	163	130,92	97,10
14	11,245	8,340	64	51,405	38,125	114	91,56	67,91	164	131,72	97,69
15	12,048	8,935	65	52,208	38,720	115	92,37	68,51	165	132,53	98,29
16	12,851	9,531	66	53,011	39,316	116	93,17	69,10	166	133,33	98,89
17	13,654	10,127	67	53,814	39,912	117	93,97	69,70	167	134,13	99,48
18	14,458	10,723	68	54,618	40,508	118	94,78	70,29	168	134,94	100,08
19	15,261	11,318	69	55,421	41,103	119	95,58	70,89	169	135,74	100,67
20	16,064	11,914	70	56,224	41,699	120	96,38	71,48	170	136,54	101,27
21	16,867	12,510	71	57,027	42,295	121	97,19	72,08	171	137,35	101,86
22	17,670	13,105	72	57,830	42,890	122	97,99	72,68	172	138,15	102,46
23	18,474	13,701	73	58,634	43,486	123	98,79	73,27	173	138,95	103,06
24	19,277	14,297	74	59,437	44,082	124	99,60	73,87	174	139,76	103,65
25	20,080	14,892	75	60,240	44,677	125	100,40	74,46	175	140,56	104,25
26	20,883	15,488	76	61,043	45,273	126	101,20	75,06	176	141,36	104,84
27	21,686	16,084	77	61,846	45,869	127	102,01	75,65	177	142,17	105,44
28	22,490	16,680	78	62,650	46,465	128	102,81	76,25	178	142,97	106,03
29	23,293	17,275	79	63,453	47,060	129	103,61	76,85	179	143,77	106,63
30	24,096	17,871	80	64,256	47,656	130	104,42	77,44	180	144,58	107,23
31	24,899	18,467	81	65,059	48,252	131	105,22	78,04	181	145,38	107,82
32	25,702	19,062	82	65,862	48,847	132	106,02	78,63	182	146,18	108,42
33	26,506	19,658	83	66,666	49,443	133	106,83	79,23	183	146,99	109,01
34	27,309	20,254	84	67,469	50,039	134	107,63	79,82	184	147,79	109,61
35	28,112	20,849	85	68,272	50,634	135	108,43	80,42	185	148,59	110,20
36	28,915	21,445	86	69,075	51,230	136	109,24	81,01	186	149,39	110,80
37	29,718	22,041	87	69,878	51,826	137	110,04	81,61	187	150,20	111,40
38	30,522	22,637	88	70,682	52,422	138	110,84	82,21	188	151,00	111,99
39	31,325	23,232	89	71,485	53,017	139	111,64	82,80	189	151,80	112,59
40	32,128	23,828	90	72,288	53,613	140	112,45	83,40	190	152,61	113,18
41	32,931	24,424	91	73,091	54,209	141	113,25	83,99	191	153,41	113,78
42	33,734	25,019	92	73,894	54,804	142	114,05	84,59	192	154,21	114,37
43	34,538	25,615	93	74,698	55,400	143	114,86	85,18	193	155,02	114,97
44	35,341	26,211	94	75,501	55,996	144	115,66	85,78	194	155,82	115,57
45	36,144	26,806	95	76,304	56,591	145	116,46	86,38	195	156,62	116,16
46	36,947	27,402	96	77,107	57,187	146	117,27	86,97	196	157,43	116,76
47	37,750	27,998	97	77,910	57,783	147	118,07	87,57	197	158,23	117,35
48	38,554	28,594	98	78,714	58,379	148	118,87	88,16	198	159,03	117,95
49	39,357	29,189	99	79,517	58,974	149	119,68	88,76	199	159,84	118,54
50	40,160	29,785	100	80,320	59,570	150	120,48	89,35	200	160,64	119,14
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Four $\frac{1}{4}$ Points. N.E. $\frac{1}{4}$ E. N.W. $\frac{1}{4}$ W. S.E. $\frac{1}{4}$ E. S.W. $\frac{1}{4}$ W.

Traverse Table for $3\frac{1}{2}$ Points. N. E. b N. $\frac{1}{2}$ E. N. W. b N. $\frac{1}{2}$ W. S. E. b S. $\frac{1}{2}$ E. S. W. b S. $\frac{1}{2}$ W.

Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.	Dift.	D. Lat.	Dep.
1	0,773	0,634	51	39,423	32,354	101	78,07	64,07	151	116,72	95,79
2	1,546	1,269	52	40,196	32,989	102	78,85	64,71	152	117,50	96,43
3	2,319	1,903	53	40,969	33,623	103	79,62	65,34	153	118,24	97,06
4	3,092	2,538	54	41,742	34,258	104	80,39	65,98	154	119,04	97,70
5	3,865	3,172	55	42,515	34,892	105	81,16	66,61	155	119,81	98,33
6	4,638	3,806	56	43,288	35,526	106	81,94	67,25	156	120,59	98,97
7	5,411	4,441	57	44,061	36,161	107	82,71	67,88	157	121,36	99,60
8	6,184	5,075	58	44,834	36,795	108	83,48	68,52	158	122,13	100,24
9	6,957	5,709	59	45,607	37,430	109	84,26	69,15	159	122,91	100,87
10	7,730	6,344	60	46,380	38,064	110	85,03	69,78	160	123,68	101,50
11	8,503	6,978	61	47,153	38,698	111	85,80	70,42	161	124,45	102,14
12	9,276	7,613	62	47,926	39,333	112	86,58	71,05	162	125,23	102,77
13	10,049	8,247	63	48,699	39,967	113	87,35	71,69	163	126,00	103,41
14	10,822	8,882	64	49,472	40,602	114	88,12	72,32	164	126,77	104,04
15	11,595	9,516	65	50,245	41,236	115	88,89	72,97	165	127,54	104,68
16	12,368	10,150	66	51,018	41,870	116	89,67	73,59	166	128,32	105,31
17	13,141	10,785	67	51,791	42,505	117	90,44	74,22	167	129,09	105,94
18	13,914	11,419	68	52,564	43,139	118	91,21	74,86	168	129,86	106,58
19	14,687	12,054	69	53,337	43,774	119	91,99	75,49	169	130,64	107,21
20	15,460	12,688	70	54,110	44,408	120	92,76	76,13	170	131,41	107,85
21	16,233	13,322	71	54,883	45,042	121	93,53	76,76	171	132,18	108,48
22	17,006	13,957	72	55,656	45,676	122	94,31	77,40	172	132,96	109,12
23	17,779	14,591	73	56,429	46,311	123	95,08	78,03	173	133,73	109,75
24	18,552	15,226	74	57,202	46,946	124	95,85	78,67	174	134,50	110,39
25	19,325	15,860	75	57,975	47,680	125	96,62	79,30	175	135,27	111,02
26	20,098	16,494	76	58,748	48,314	126	97,40	79,93	176	136,05	111,65
27	20,871	17,129	77	59,521	48,849	127	98,17	80,57	177	136,82	112,29
28	21,644	17,763	78	60,294	49,483	128	98,94	81,20	178	137,59	112,92
29	22,417	18,398	79	61,067	50,118	129	99,72	81,84	179	138,37	113,56
30	23,190	19,032	80	61,840	50,752	130	100,49	82,47	180	139,14	114,19
31	23,963	19,666	81	62,613	51,386	131	101,26	83,11	181	139,91	114,83
32	24,736	20,301	82	63,386	52,021	132	102,04	83,74	182	140,69	115,46
33	25,509	20,935	83	64,159	52,655	133	102,81	84,37	183	141,46	116,09
34	26,282	21,570	84	64,932	53,290	134	103,58	85,01	184	142,23	116,73
35	27,055	22,204	85	65,705	53,924	135	104,35	85,64	185	143,00	117,36
36	27,828	22,838	86	66,478	54,558	136	105,13	86,28	186	143,78	118,00
37	28,601	23,473	87	67,251	55,193	137	105,90	86,91	187	144,55	118,63
38	29,374	24,107	88	68,024	55,827	138	106,67	87,55	188	145,32	119,27
39	30,147	24,742	89	68,797	56,462	139	107,45	88,18	189	146,10	119,91
40	30,920	25,376	90	69,570	57,096	140	108,22	88,82	190	146,87	120,54
41	31,693	26,010	91	70,343	57,730	141	108,99	89,45	191	147,64	121,17
42	32,466	26,645	92	71,116	58,365	142	109,77	90,08	192	148,42	121,80
43	33,239	27,279	93	71,889	58,999	143	110,54	90,72	193	149,19	122,44
44	34,012	27,914	94	72,662	59,634	144	111,31	91,35	194	149,96	123,07
45	34,785	28,548	95	73,435	60,268	145	112,08	91,98	195	150,73	123,71
46	35,558	29,182	96	74,208	60,902	146	112,86	92,62	196	151,51	124,34
47	36,331	29,817	97	74,981	61,537	147	113,63	93,26	197	152,28	124,98
48	37,104	30,451	98	75,754	62,171	148	114,40	94,89	198	153,05	125,61
49	37,877	31,086	99	76,527	62,806	149	115,18	94,53	199	153,83	126,25
50	38,650	31,720	100	77,300	63,440	150	115,95	95,16	200	154,60	126,88
Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.	Dift.	Dep.	D. Lat.

Four $\frac{1}{2}$ Points. N. E. $\frac{1}{2}$ E. N. W. $\frac{1}{2}$ W. S. E. $\frac{1}{2}$ E. S. W. $\frac{1}{2}$ W.

Traverse Table for $3\frac{1}{2}$ Points. N. E. b N. $\frac{1}{4}$ E. N. W. b N. $\frac{1}{4}$ W. S. E. b S. $\frac{1}{4}$ E. S. W. b S. $\frac{1}{4}$ W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,741	0,671	51	37,791	34,252	101	74,84	67,83	151	111,89	101,41
2	1,482	1,343	52	38,532	34,923	102	75,58	68,50	152	112,63	102,08
3	2,228	2,015	53	39,273	35,595	103	76,32	69,17	153	113,37	102,75
4	2,964	2,686	54	40,014	36,266	104	77,06	69,85	154	114,11	103,43
5	3,705	3,358	55	40,755	36,938	105	77,80	70,52	155	114,85	104,10
6	4,446	4,029	56	41,496	37,610	106	78,55	71,19	156	115,60	104,77
7	5,187	4,701	57	42,237	38,281	107	79,29	71,86	157	116,34	105,44
8	5,928	5,372	58	42,978	38,953	108	80,03	72,53	158	117,08	106,11
9	6,668	6,044	59	43,719	39,624	109	80,77	73,20	159	117,82	106,78
10	7,409	6,716	60	44,460	40,296	110	81,51	73,88	160	118,56	107,46
11	8,151	7,388	61	45,201	40,968	111	82,25	74,55	161	119,30	108,13
12	8,892	8,059	62	45,942	41,639	112	82,99	75,22	162	120,04	108,80
13	9,633	8,731	63	46,683	42,311	113	83,73	75,89	163	120,78	109,47
14	10,374	9,402	64	47,424	42,982	114	84,47	76,56	164	121,52	110,14
15	11,115	10,074	65	48,165	43,654	115	85,21	77,23	165	122,26	110,81
16	11,856	10,746	66	48,906	44,326	116	85,96	77,91	166	123,01	111,49
17	12,597	11,417	67	49,647	44,997	117	86,70	78,58	167	123,75	112,16
18	13,338	12,089	68	50,388	45,669	118	87,44	79,25	168	124,49	112,83
19	14,079	12,760	69	51,129	46,340	119	88,18	79,92	169	125,23	113,50
20	14,820	13,432	70	51,870	47,012	120	88,92	80,59	170	125,97	114,17
21	15,561	14,104	71	52,611	47,684	121	89,66	81,26	171	126,71	114,84
22	16,302	14,775	72	53,352	48,355	122	90,40	81,94	172	127,45	115,51
23	17,043	15,447	73	54,093	49,027	123	91,14	82,61	173	128,19	116,19
24	17,784	16,118	74	54,834	49,698	124	91,88	83,28	174	128,93	116,86
25	18,525	16,790	75	55,575	50,370	125	92,62	83,95	175	129,67	117,53
26	19,266	17,462	76	56,316	51,042	126	93,37	84,62	176	130,42	118,20
27	20,007	18,133	77	57,057	51,713	127	94,11	85,29	177	131,16	118,87
28	20,748	18,805	78	57,798	52,385	128	94,85	85,96	178	131,90	119,54
29	21,489	19,476	79	58,539	53,056	129	95,59	86,64	179	132,64	120,22
30	22,230	20,148	80	59,280	53,728	130	96,33	87,31	180	133,38	120,89
31	22,971	20,820	81	60,021	54,400	131	97,07	87,98	181	134,12	121,56
32	23,712	21,491	82	60,762	55,071	132	97,81	88,65	182	134,86	122,23
33	24,453	22,163	83	61,503	55,743	133	98,55	89,32	183	135,60	122,90
34	25,194	22,834	84	62,244	56,414	134	99,29	89,99	184	136,34	123,57
35	25,935	23,506	85	62,985	57,086	135	100,03	90,67	185	137,08	124,25
36	26,676	24,178	86	63,726	57,757	136	100,78	91,34	186	137,83	124,92
37	27,417	24,849	87	64,467	58,429	137	101,52	92,01	187	138,57	125,59
38	28,158	25,521	88	65,208	59,101	138	102,26	92,68	188	139,31	126,26
39	28,899	26,192	89	65,949	59,772	139	103,00	93,35	189	140,05	126,93
40	29,640	26,864	90	66,690	60,441	140	103,74	94,02	190	140,79	127,60
41	30,381	27,532	91	67,431	61,116	141	104,48	94,70	191	141,53	128,28
42	31,122	28,207	92	68,172	61,787	142	105,22	95,37	192	142,27	128,95
43	31,863	28,879	93	68,913	62,459	143	105,96	96,04	193	143,01	129,62
44	32,604	29,550	94	69,654	63,130	144	106,70	96,71	194	143,75	130,29
45	33,345	30,222	95	70,395	63,802	145	107,44	97,38	195	144,49	130,96
46	34,086	30,894	96	71,136	64,474	146	108,19	98,05	196	145,24	131,63
47	34,827	31,565	97	71,877	65,145	147	108,93	98,72	197	145,98	132,31
48	35,568	32,237	98	72,618	65,817	148	109,67	99,40	198	146,72	132,98
49	36,309	32,908	99	73,359	66,488	149	110,41	100,07	199	147,46	133,65
50	37,050	33,580	100	74,100	67,160	150	111,15	100,74	200	148,20	134,32
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Four $\frac{1}{4}$ Points. N. E. $\frac{1}{4}$ E. N. W. $\frac{1}{4}$ W. S. E. $\frac{1}{4}$ E. S. W. $\frac{1}{4}$ W.

Traverse Table for 4 Points. N. E. N. W. S. E. S. W.

Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.	Dist.	D. Lat.	Dep.
1	0,707	0,707	51	36,062	36,062	101	71,42	71,42	151	106,77	106,77
2	1,414	1,414	52	36,769	36,769	102	72,12	72,12	152	107,48	107,48
3	2,121	2,121	53	37,476	37,476	103	72,83	72,83	153	108,19	108,19
4	2,828	2,828	54	38,183	38,183	104	73,54	73,54	154	108,89	108,89
5	3,535	3,535	55	38,890	38,890	105	74,25	74,25	155	109,60	109,60
6	4,243	4,243	56	39,598	39,598	106	74,95	74,95	156	110,31	110,31
7	4,950	4,950	57	40,305	40,305	107	75,66	75,66	157	111,01	111,01
8	5,057	5,057	58	41,012	41,012	108	76,37	76,37	158	111,72	111,72
9	6,364	6,364	59	41,719	41,719	109	77,07	77,07	159	112,43	112,43
10	7,071	7,071	60	42,426	42,426	110	77,78	77,78	160	113,14	113,14
11	7,778	7,778	61	43,133	43,133	111	78,49	78,49	161	113,84	113,84
12	8,485	8,485	62	43,840	43,840	112	79,19	79,19	162	114,55	114,55
13	9,192	9,192	63	44,547	44,547	113	79,90	79,90	163	115,26	115,26
14	9,899	9,899	64	45,254	45,254	114	80,61	80,61	164	115,96	115,96
15	10,606	10,606	65	45,961	45,961	115	81,32	81,32	165	116,67	116,67
16	11,314	11,314	66	46,669	46,669	116	82,02	82,02	166	117,38	117,38
17	12,021	12,021	67	47,376	47,376	117	82,73	82,73	167	118,09	118,09
18	12,728	12,728	68	48,083	48,083	118	83,44	83,44	168	118,79	118,79
19	13,435	13,435	69	48,790	48,790	119	84,14	84,14	169	119,50	119,50
20	14,142	14,142	70	49,497	49,497	120	84,85	84,85	170	120,21	120,21
21	14,849	14,849	71	50,204	50,204	121	85,56	85,56	171	120,91	120,91
22	15,556	15,556	72	50,911	50,911	122	86,27	86,27	172	121,62	121,62
23	16,263	16,263	73	51,618	51,618	123	86,97	86,97	173	122,33	122,33
24	16,970	16,970	74	52,325	52,325	124	87,68	87,68	174	123,04	123,04
25	17,677	17,677	75	53,032	53,032	125	88,39	88,39	175	123,74	123,74
26	18,385	18,385	76	53,740	53,740	126	89,09	89,09	176	124,45	124,45
27	19,092	19,092	77	54,447	54,447	127	89,80	89,80	177	125,16	125,16
28	19,799	19,799	78	55,154	55,154	128	90,51	90,51	178	125,86	125,86
29	20,506	20,506	79	55,861	55,861	129	91,22	91,22	179	126,57	126,57
30	21,213	21,213	80	56,568	56,568	130	91,92	91,92	180	127,28	127,28
31	21,920	21,920	81	57,275	57,275	131	92,63	92,63	181	127,98	127,98
32	22,627	22,627	82	57,982	57,982	132	93,34	93,34	182	128,69	128,69
33	23,334	23,334	83	58,689	58,689	133	94,04	94,04	183	129,40	129,40
34	24,041	24,041	84	59,396	59,396	134	94,75	94,75	184	130,11	130,11
35	24,748	24,748	85	60,103	60,103	135	95,46	95,46	185	130,81	130,81
36	25,456	25,456	86	60,811	60,811	136	96,17	96,17	186	131,52	131,52
37	26,163	26,163	87	61,518	61,518	137	96,87	96,87	187	132,23	132,23
38	26,870	26,870	88	62,225	62,225	138	97,58	97,58	188	132,93	132,93
39	27,577	27,577	89	62,932	62,932	139	98,29	98,29	189	133,64	133,64
40	28,284	28,284	90	63,639	63,639	140	98,99	98,99	190	134,35	134,35
41	28,991	28,991	91	64,346	64,346	141	99,70	99,70	191	135,06	135,06
42	29,698	29,698	92	65,053	65,053	142	100,41	100,41	192	135,76	135,76
43	30,405	30,405	93	65,760	65,760	143	101,12	101,12	193	136,47	136,47
44	31,112	31,112	94	66,467	66,467	144	101,82	101,82	194	137,18	137,18
45	31,819	31,819	95	67,174	67,174	145	102,53	102,53	195	137,88	137,88
46	32,527	32,527	96	67,882	67,882	146	103,24	103,24	196	138,59	138,59
47	33,234	33,234	97	68,589	68,589	147	103,94	103,94	197	139,30	139,30
48	33,941	33,941	98	69,296	69,296	148	104,65	104,65	198	140,01	140,01
49	34,648	34,648	99	70,003	70,003	149	105,36	105,36	199	140,71	140,71
50	35,355	35,355	100	70,710	70,710	150	106,06	106,06	200	141,72	141,72
Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.	Dist.	Dep.	D. Lat.

Four Points. N. E. N. W. S. E. S. W.

The **USE** of the foregoing **TABLE**, is for working the courses and distances sailed, in each day; by this table are found, how many miles the ship has altered, or differed her lat. towards the N. or S. and the miles she has departed from the mer. (that day) E. or W.

EXAMPLES of single COURSES.

Ex. 1. Suppose a ship sailed S.W. (from the Lizard) 100 miles: What has she differed her lat. and what dep. has she made from the meridian of the Lizard? See Def. 13, p. 34.

By the table under the course S.W. and against 100 in distance column, is 70,71 in lat. column, and the same in dep. column: Now, 70,7 is 70 miles and 7 tenths of a mile; and because 10 tenths make one, therefore, to take the diff. of latitude and departure in whole miles without parts, you may call the diff. of latitude 71 miles S. and the dep. 71 W. because the course was Southwest, and the diff of lat. must be S. and the dep. W.

2. Suppose she had sailed 150 miles S.W. then she would have differed her lat. 106' S. and departed 106' W.

3. Suppose she sailed 200 miles, the same course S.W. she would have made 141',7 South-ing, and 141',7 Westing. And if she had sailed that course 2000 miles, then she would have differed her lat. 1417,2, and departed 1417,2; for as the distance is ten times more than 200, so must her diff. of lat. and dep. be also 10 times more than they were for 200; and the like for any other course or distance.

4. Suppose a ship sailed W.S.W. 100 m. What diff. of lat. and dep. has she made? Over the course 6 points (W.S.W.) and against the dist. 100, is X lat. 92,39 and dep. 38,269; but in this, and in all other cases, as one place of decimal parts is sufficient, we shall therefore call the X lat. 92,4, and the dep. 38,3 W.

Note. When the second place of decimals, towards the right hand, is more than 5, add 1 for it to the figure in the first place of decimals, as in the above and in the following cases. But it was found necessary that there should be two places of decimals in the table, in order to find large distances. Having given the diff. of latitude and the departure, the course and distance may be found in this table; and the course or bearing may be obtained to the nearest degree of its bearing, which is evidently sufficient in any course or bearing, for the purposes of navigation: And, in general, it is sufficient to have (or to find) the bearing to the nearest point and $\frac{1}{4}$ of the compass; because a ship cannot be steered to a quantity less than that of the nearest $\frac{1}{4}$ point of the course from one place to another.

5. A ship sailed S.W.bS. till she differed her lat. 138 miles: What dist. and dep. has she made?

By the table under S.W.bS. in lat. col. I find 138,0 lat. 166 dist. and 92,2 dep. which is 92' W.

6. A ship sailed in the N.E. quarter, till she made 195 miles dist. and 100 dep. What course had she sailed, and what has she differed her latitude?

Find in the table 195 in dist. col. and 100 against it in dep. col. and you will have the course N.N.E. $\frac{3}{4}$ E. and the diff. of lat. 167' N. consequently, she has differed her lat. 2°.47' N.

7. A ship sailed 140 miles North-easterly, and differed her lat. 134 N. What was her course; and how many miles has she departed from the meridian sailed from? Answer: She sailed N.bE. $\frac{1}{2}$ E. and departed 40,6 E.

8. A ship sailed W.S.W. till she had made 100 miles dep. What distance had she sailed; and what had she differed her latitude? Answer: She sailed 108 miles, and differed her lat. 41 miles South.

9. A ship sailed on various courses, and made 160' S. and 96' E. What course and distance had she made good? Answer: S.S.E. $\frac{3}{4}$ E. 187 miles. These are all the different cases that can happen in sailing.

In the 1st, 2d, 3d, 4th examples, the course and distance are given.

In the 5th, — the course and X latitude are given.

In the 6th, — the dist. and dep. do.

In the 7th, — the dist. and X lat. do.

In the 8th, — the course and dep. do.

In the 9th, — the X lat. and dep. do.

OF CORRECTING the DEAD RECKONING.

PATOUN's Navigation, p. 314. Rule. If the courses are for the most part near the parallel of East and West, and the direct course be within $5\frac{1}{2}$ or 6 points of the meridian*; then if the latitude by account differs from the observed latitude, it is most probable that the error lies in the course, or distance, or perhaps in both; for in this case 'tis evident, the departure by account will be very nearly true; and thence the true course and distance may be found.

REMARKS on this RULE.

The author of the Rule for correcting, when the latitudes differ, says, that it is most probable, the error lies in the course, or distance, or in both. If the course and distance be true, all things deduced from them must also be true; to wit. The difference of latitude, departure, and difference of longitude; but if the course be not true, it must either have been steered wrong, or defectively corrected; if the distance be wrong, it must be, by the error of the distance deduced by the log and glass (as explained in p. 119 to p. 122), which can only be a small error; and, in this case, it would not differ the latitude more than two or three minutes; therefore, if the error of latitude exceed this quantity, it must be occasioned by a drift of the water, whether the drift was produced by the wind or tide, for all motions of a ship through the water are made by wind and water; and when the error of latitude is considerable, you may correct by taking the most probable course for the drift, by the current, and the error of latitude, for the difference of latitude, by which you will find the departure, to be applied to the departure before found; then, by the true X latitude, and this departure, find the course and distance made good; and then find the longitude made, and the lon. in, by Art. 6, p. 102. Illustration.

By figure B, plate 4. Let A, be the place of a ship the foregoing day at noon, and that she has made her course good by account, due E. dist. 100', but by observation finds the error of lat. 6, 8 or 10' N. I say this could not be produced by either an error in the course or distance, but by the current; and this current might so effect the ship that she might make $Ab = AC$, the true distance; and the error produced in this would be only in latitude = AM . 2. The ship might arrive at a , or b , wherein there would be an error in the course and distance made good, as also in the latitude and departure; and that the ship at w , c , d or e , &c. with the same distance, would differently err in latitude, from that at b , in the course, in distance and departure, as is evident by the figure: And the like of all other corrections.

In this case, it is not possible to correct the course, the distance, or the departure; therefore, the correct longitude of the day is not determinable.

A ship might steer to make a place as E, and might arrive at a place represented by M, N, O, P, e , d , c , a , or B. Now, if she was at a , or M, the latitudes would agree; but in every other place, would be wrong. If she was (at N), O, P, &c. there would be an error in every particular of account; and the like of the places e , d , c , B, &c. which is so evident that nothing further need be said about correcting reckonings. See page 117, 119, 121, 122.

* By direct course, is to be understood, the course made good, after any number of courses failed.

TERMS of ART, &c. used by SEAMEN.

A.

ANCHOR. That massy Iron, which being cast into the Sea or River, and by entering into the Ground, holds the ship by the Cable which is fastened to both.

Aft, or Abaft. That part of the Ship towards the Stern.

Sheet Anchor. Is the largest Anchor; the next are the First and Second Bowers, or best and small bowers; Kedge and Grappling Anchors are the smallest.

The Anchor is said to *come home*, when it does not hold the ship, but lets her drive.

The Anchor is a *peak*, when it is under the Hawse Hole, through which its Cable runs out. And it is a *Cock-bell*, when it hangs right up and down, ready to be dropped.

Pudding of the Anchor. The Ropes which are wound round the Ring, to save the Clinch of the Cable from being galled.

B.

Bear up. Let the ship sail more before the wind, or further from it.

Belay. Make the Rope fast.

Bitts. Are two main Pieces of Timber standing like a Pillar behind the Manger, in the Loof of the Ship, with a cross Piece for belaying the Cable when the Ship rides at Anchor.

Board and Board. When two Ships come so near as to touch one another.

To make a Board. Is to sail to Windward.

To bend the Sails. Is to fasten them to the Yards.

To bend a Cable. Is to fasten it to the Anchor.

Bow-line. Is a Rope made fast to the Leech, or middle part of the Outside of the sail; it is fastened by two or three, or more parts, to the sail; but the Mizzen Bow-line is fastened to the lower End of the Yard: This Line belongs to all Sails except the Sprit-sail and Sprit-top-sail; for which they cannot be used close by a Wind; Bow-lines are used to make the Sails stand sharp, or close by the Wind.

Braces. Are Ropes belonging to all the Yards of a Ship, except the Mizzen; two to each Yard, reeved through blocks that are fastened to pennants fixed to the Yard-arms; their Use is either to square the Yards, or to traverse them: All these Braces come aftwards on; the Main Braces come to the Poop, the Main-top-sail Braces to the Mizzen-top, and thence to the Mizzen Shrouds; the Fore and Fore-top-sail Braces come down by the Main and Main-top-sail Stays; the Cross Jack Braces are brought forwards to the Main-shrouds, when a Ship sails close by the Wind.

Buoy. A Piece of Wood, or close hooped Barrel, fastened so as to float over the Anchor.

Stream the Buoy. Let the Anchor fall while the Ship has way.

C.

Cable. Is a Rope, which being fastened to the Anchor, and the Anchor let go, the Ship rides by it.

Veer more Cable. That is, let more of it run out.

To bend or unbend a Cable. Is to fasten it to, or loose it from, the ring of the Anchor.

Capstan. Ships have usually two; the Main and Jeer Capstans.

Main Capstan. Is a large Piece of Timber, and serves as a windlass, but stands perpendicular abaft the Main-mast, its Foot standing in a Step on the lower Deck, and its Head between the upper Decks, formed into several Squares with Holes in them for the Bars: Its chief use is to weigh the Anchor; that is, to hoist it up.

Cheffe-trees. Two Pieces of Timber, with a Hole in each of them, on each Side of the Ship, made for the Main-tack to run through, and to haul it down to.

Cheats, or Chevets. Are Pieces of Wood fastened to the Yard-arms, to keep the Ropes from slipping off the Yard.

Close-hauled. A Ship is said to be close-hauled, when her Sails are trimmed sharp, so as to sail as near the Wind as possible.

Clew of a Sail. Is the lower Corner of it, to which are made fast the Sheats and Tacks.

Courses. Are the lower Sails; particularly, the Main and Fore-sails.

D.

Deck of a Ship. Is a Floor planked from Stem to Stern. Some Ships have two Decks, and large Ships three Decks. The *Half-deck* reaches from the Main-mast to the Stern; the *Quarter-deck*, is that aloft the Steerage, reaching to the Round-house.

F.

Fall of a Tackle. Is that Part of a Rope by which you haul.

Furl, (bind or make up). To furl a Sail, is to wrap it up and bind it close to the Yard.

H.

Hawses. Are great Holes in the Ship's Head, thro' which the cables run.

Fresh the Hawse. Veer out more cable.

Hawser. A great Rope, or small Cable.

Head-sails. Are the sails which belong to the Fore-mast and Bow-sprit; for they govern the Head of the Ship, and make her fall off.

Helm, or Tiller. Is that Piece of Timber which is fastened to the Rudder, and comes into the Steerage: By it the Rudder is turned to and fro in the Water abaft the Ship; and it causes her to go with her Head more to Windward or Leeward.

Bear

H.

Bear up the Helm. That is, let the Ship go more large before the Wind.

Right the Helm. Put it in Direction of the Middle of the Ship.

Bear up round. Let the Ship sail directly before the Wind.

Port the Helm. Put the Helm over to the Left Side of the Ship.

Starboard the Helm. Put it over to the Right Side, (you looking forwards) of the Ship.

Ease the Helm. Let the Ship go more large.

Hoise. Is to haul up any thing.

Hull of a Ship. Is the Body from Stem to Stern, without masts or Rigging.

To hull, or to lie a-Hull. Is when she cannot carry Sail; when they are all taken in, and the Helm is lashed fast to the Lee-side of the Ship.

L.

Large. A Ship goes large, when she sails neither before the Wind nor upon it, and with all Sails drawing.

Loof, or Luff. Keep the Ship near the Wind.

Loxodromic-line. Is the Line of the Ship's Way when she sails upon a Rumb, oblique to the Meridian.

M.

To moor a Ship. Is to get her into a convenient place, for her safe Riding, and when she has two Anchors out, or more, she is moored.

P.

Poop of a Ship. Is the uppermost Part of her Hull a-stern.

R.

Rake of a Ship. Is so much of her Hull as hangs over both Ends of her Keel. The Rudder has a Rake also.

Rudder of a Ship. Is the Piece of Timber which hangs at the Stern-post; by it, Steersmen keep the Ship in her Course.

Rumb-line. Is the Line of the Course, to be described by a Ship on the Surface of the Sea, steered by the Compass, making equal Angles with every Meridian. See Nautical Def. p. 34.

S.

Sheer, to swing too and fro. The Ship sheers when she goes in and out, and not right forwards.

Sheats. Are Ropes bent to the Clew of the Sails. The main Sheats haled aft, makes a Ship keep by a Wind; the Fore-sheats haled aft, makes the Ship fall off from the Wind. *Ease the Sheat;* that is, veer it, or let it go out gently. *Let fly the Sheat;* that is, let it go all at once, to run out fast; and the Sail will hang loose, and hold no Wind.

To shiver a Sail. Is to bring the Yard in Direction of the Wind.

S.

Sounding. Is to try the Depth of Water by a Line and a Plummert of Lead.

To bring a Ship upon her Stays, for her Tacking. Bear up the Helm, let fly the Fore-sheat, let go the Fore-bow-line, brace the Weather-brace of the Fore-sail, Fore-top-sail, and Top-gallant sail; let go the Sprit-sail Sheat, and Fore-Sheat, and brace the Weather-brace. When the Head of the Ship has passed the Wind, and that it comes in at the other Bow, it drives the Sails backwards against the Shrouds and Masts, so that the Ship drives a Broadside. Ships, which will stay with the fewest Sails, are reckoned the best.

T.

To trim the Sails, so as to stand close to a Wind. Bring the Main, Fore, and Mizzen Tack close by the Board, and overhauled, and as forward as they can be; also the Bow-lines on the Weather-side, the Lee-sheats haled close aft; and the Lee-braces of all the Sails are braced aft, and the Top-sails braced, &c. as the Sails to which they belong.

To find the Trim of a Ship. That is, to find how she will sail best: This is done by Trial of her sailing with another Ship, when trimmed a-head, a-stern, and upon an even Keel; also by easing her Masts and Shrouds.

To try; as to try how the Ship lies under a Main-sail, or Main-course: Which is, when she has no other Sails abroad; the Tacks haled close aboard, the Bow-lines set up, the Sheats haled close aft, and the Helm tied down close by the Board; and so she is let lie in the Sea.

To try under a Mizzen. Which is done when it blows so hard that they cannot keep the Main-sail, i. e. cannot keep it out. If a Ship will neither try nor hull, then spoom her; that is, put her right before the Wind.

V.

Veer, veer out Rope, or the Wind veers, or changes. A Ship goes veering, when she goes large; that is, neither by it, nor before it, but between.

W.

Wake of a Ship. Is the smooth Water a-stern, when she is under sail; this shews the Way she has gone in the Sea, and by which the Mariners judge what Lee-way she makes.

To weather a Point of Land. Or a Ship is to pass it on the Weather Side, or to Windward of it.

To have the Wind of a Ship. Is to be to Windward of her.

Y.

Brace the Yard. That is, bring the Yard-arm aft, whose Brace is haled.

Square the Yards. That is, make them stand right a-cross the Ship.

Diff.

1°. Difference of Latitude and Departure for 1 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	01,0	00,0	51	51,0	00,9	101	101,0	01,8	151	151,0	02,6	201	201,0	03,5	251	251,0	04,3
2	02,0	00,0	52	52,0	00,9	102	102,0	01,8	152	152,0	02,6	202	202,0	03,5	252	252,0	04,3
3	03,0	00,1	53	53,0	00,9	103	103,0	01,8	153	153,0	02,6	203	203,0	03,5	253	253,0	04,3
4	04,0	00,1	54	54,0	00,9	104	104,0	01,8	154	154,0	02,7	204	204,0	03,5	254	254,0	04,4
5	05,0	00,1	55	55,0	01,0	105	105,0	01,8	155	155,0	02,7	205	205,0	03,5	255	255,0	04,4
6	06,0	00,1	56	56,0	01,0	106	106,0	01,8	156	156,0	02,7	206	206,0	03,5	256	256,0	04,4
7	07,0	00,1	57	57,0	01,0	107	107,0	01,9	157	157,0	02,7	207	207,0	03,6	257	257,0	04,4
8	08,0	00,1	58	58,0	01,0	108	108,0	01,9	158	158,0	02,7	208	208,0	03,6	258	258,0	04,4
9	09,0	00,2	59	59,0	01,0	109	109,0	01,9	159	159,0	02,7	209	209,0	03,6	259	259,0	04,4
10	10,0	00,2	60	60,0	01,1	110	110,0	01,9	160	160,0	02,8	210	210,0	03,6	260	260,0	04,5
11	11,0	00,2	61	61,0	01,1	111	111,0	01,9	161	161,0	02,8	211	211,0	03,6	261	261,0	04,5
12	12,0	00,2	62	62,0	01,1	112	112,0	02,0	162	162,0	02,8	212	212,0	03,6	262	262,0	04,5
13	13,0	00,2	63	63,0	01,1	113	113,0	02,0	163	163,0	02,8	213	213,0	03,7	263	263,0	04,5
14	14,0	00,2	64	64,0	01,1	114	114,0	02,0	164	164,0	02,8	214	214,0	03,7	264	264,0	04,5
15	15,0	00,3	65	65,0	01,1	115	115,0	02,0	165	165,0	02,9	215	215,0	03,7	265	265,0	04,6
16	16,0	00,3	66	66,0	01,2	116	116,0	02,0	166	166,0	02,9	216	216,0	03,7	266	266,0	04,6
17	17,0	00,3	67	67,0	01,2	117	117,0	02,0	167	167,0	02,9	217	217,0	03,7	267	267,0	04,6
18	18,0	00,3	68	68,0	01,2	118	118,0	02,1	168	168,0	02,9	218	218,0	03,8	268	268,0	04,6
19	19,0	00,3	69	69,0	01,2	119	119,0	02,1	169	169,0	02,9	219	219,0	03,8	269	269,0	04,6
20	20,0	00,4	70	70,0	01,2	120	120,0	02,1	170	170,0	02,9	220	220,0	03,8	270	270,0	04,6
21	21,0	00,4	71	71,0	01,2	121	121,0	02,1	171	171,0	03,0	221	221,0	03,8	271	271,0	04,7
22	22,0	00,4	72	72,0	01,3	122	122,0	02,1	172	172,0	03,0	222	222,0	03,8	272	272,0	04,7
23	23,0	00,4	73	73,0	01,3	123	123,0	02,1	173	173,0	03,0	223	223,0	03,8	273	273,0	04,7
24	24,0	00,4	74	74,0	01,3	124	124,0	02,2	174	174,0	03,0	224	224,0	03,9	274	274,0	04,7
25	25,0	00,4	75	75,0	01,3	125	125,0	02,2	175	175,0	03,0	225	225,0	03,9	275	275,0	04,7
26	26,0	00,5	76	76,0	01,3	126	126,0	02,2	176	176,0	03,0	226	226,0	03,9	276	276,0	04,7
27	27,0	00,5	77	77,0	01,3	127	127,0	02,2	177	177,0	03,1	227	227,0	03,9	277	277,0	04,8
28	28,0	00,5	78	78,0	01,4	128	128,0	02,2	178	178,0	03,1	228	228,0	03,9	278	278,0	04,8
29	29,0	00,5	79	79,0	01,4	129	129,0	02,2	179	179,0	03,1	229	229,0	03,9	279	279,0	04,8
30	30,0	00,5	80	80,0	01,4	130	130,0	02,3	180	180,0	03,1	230	230,0	04,0	280	280,0	04,8
31	31,0	00,5	81	81,0	01,4	131	131,0	02,3	181	181,0	03,1	231	231,0	04,0	281	281,0	04,8
32	32,0	00,6	82	82,0	01,4	132	132,0	02,3	182	182,0	03,1	232	232,0	04,0	282	282,0	04,8
33	33,0	00,6	83	83,0	01,5	133	133,0	02,3	183	183,0	03,2	233	233,0	04,0	283	283,0	04,9
34	34,0	00,6	84	84,0	01,5	134	134,0	02,3	184	184,0	03,2	234	234,0	04,0	284	284,0	04,9
35	35,0	00,6	85	85,0	01,5	135	135,0	02,3	185	185,0	03,2	235	235,0	04,0	285	285,0	04,9
36	36,0	00,6	86	86,0	01,5	136	136,0	02,4	186	186,0	03,2	236	236,0	04,1	286	286,0	04,9
37	37,0	00,6	87	87,0	01,5	137	137,0	02,4	187	187,0	03,2	237	237,0	04,1	287	287,0	04,9
38	38,0	00,7	88	88,0	01,5	138	138,0	02,4	188	188,0	03,3	238	238,0	04,1	288	288,0	04,9
39	39,0	00,7	89	89,0	01,6	139	139,0	02,4	189	189,0	03,3	239	239,0	04,1	289	289,0	05,0
40	40,0	00,7	90	90,0	01,6	140	140,0	02,4	190	190,0	03,3	240	240,0	04,1	290	290,0	05,0
41	41,0	00,7	91	91,0	01,6	141	141,0	02,4	191	191,0	03,3	241	241,0	04,1	291	291,0	05,0
42	42,0	00,7	92	92,0	01,6	142	142,0	02,5	192	192,0	03,3	242	242,0	04,2	292	292,0	05,0
43	43,0	00,8	93	93,0	01,6	143	143,0	02,5	193	193,0	03,3	243	243,0	04,2	293	293,0	05,0
44	44,0	00,8	94	94,0	01,6	144	144,0	02,5	194	194,0	03,4	244	244,0	04,2	294	294,0	05,0
45	45,0	00,8	95	95,0	01,7	145	145,0	02,5	195	195,0	03,4	245	245,0	04,2	295	295,0	05,1
46	46,0	00,8	96	96,0	01,7	146	146,0	02,5	196	196,0	03,4	246	246,0	04,2	296	296,0	05,1
47	47,0	00,8	97	97,0	01,7	147	147,0	02,5	197	197,0	03,4	247	247,0	04,2	297	297,0	05,1
48	48,0	00,8	98	98,0	01,7	148	148,0	02,6	198	198,0	03,4	248	248,0	04,3	298	298,0	05,1
49	49,0	00,9	99	99,0	01,7	149	149,0	02,6	199	199,0	03,4	249	249,0	04,3	299	299,0	05,1
50	50,0	00,9	100	100,0	01,7	150	150,0	02,6	200	200,0	03,5	250	250,0	04,4	300	300,0	05,2
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 89 Deg.

2°. Difference of Latitude and Departure for 2 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,00,0		51	51,00,1,8		101	100,903,5		151	150,905,3		201	200,907,0		251	250,808,8	
2	02,00,1		52	52,00,1,8		102	101,903,6		152	151,905,3		202	201,907,1		252	251,808,8	
3	03,00,1		53	53,00,1,8		103	102,903,6		153	152,905,4		203	202,907,1		253	252,808,8	
4	04,00,1		54	54,00,1,9		104	103,903,6		154	153,905,4		204	203,907,1		254	253,808,9	
5	05,00,2		55	55,00,1,9		105	104,903,7		155	154,905,4		205	204,907,2		255	254,808,9	
6	06,00,2		56	56,00,2,0		106	105,903,7		156	155,905,5		206	205,907,2		256	255,809,0	
7	07,00,2		57	57,00,2,0		107	106,903,7		157	156,905,5		207	206,907,2		257	256,809,0	
8	08,00,3		58	58,00,2,0		108	107,903,8		158	157,905,5		208	207,907,3		258	257,809,0	
9	09,00,3		59	59,00,2,1		109	108,903,8		159	158,905,6		209	208,907,3		259	258,809,1	
10	10,00,4		60	60,00,2,1		110	109,903,8		160	159,905,6		210	209,907,4		260	259,809,1	
11	11,00,4		61	61,00,2,1		111	110,903,9		161	160,905,6		211	210,907,4		261	260,809,1	
12	12,00,4		62	62,00,2,2		112	111,903,9		162	161,905,7		212	211,907,4		262	261,809,2	
13	13,00,5		63	63,00,2,2		113	112,904,0		163	162,905,7		213	212,907,5		263	262,809,2	
14	14,00,5		64	64,00,2,2		114	113,904,0		164	163,905,7		214	213,907,5		264	263,809,2	
15	15,00,5		65	65,00,2,3		115	114,904,0		165	164,905,8		215	214,907,5		265	264,809,3	
16	16,00,6		66	66,00,2,3		116	115,904,1		166	165,905,8		216	215,907,6		266	265,809,3	
17	17,00,6		67	67,00,2,3		117	116,904,1		167	166,905,8		217	216,907,6		267	266,809,3	
18	18,00,6		68	68,00,2,4		118	117,904,1		168	167,905,9		218	217,907,6		268	267,809,4	
19	19,00,7		69	69,00,2,4		119	118,904,2		169	168,905,9		219	218,907,7		269	268,809,4	
20	20,00,7		70	70,00,2,4		120	119,904,2		170	169,906,0		220	219,907,7		270	269,809,5	
21	21,00,7		71	71,00,2,5		121	120,904,2		171	170,906,0		221	220,907,7		271	270,809,5	
22	22,00,8		72	72,00,2,5		122	121,904,3		172	171,906,0		222	221,907,8		272	271,809,5	
23	23,00,8		73	73,00,2,5		123	122,904,3		173	172,906,1		223	222,907,8		273	272,809,6	
24	24,00,8		74	74,00,2,6		124	123,904,3		174	173,906,1		224	223,907,8		274	273,809,6	
25	25,00,9		75	75,00,2,6		125	124,904,4		175	174,906,1		225	224,907,9		275	274,809,6	
26	26,00,9		76	76,00,2,7		126	125,904,4		176	175,906,2		226	225,907,9		276	275,809,7	
27	27,00,9		77	77,00,2,7		127	126,904,4		177	176,906,2		227	226,907,9		277	276,809,7	
28	28,00,1,0		78	78,00,2,7		128	127,904,5		178	177,906,2		228	227,908,0		278	277,809,7	
29	29,00,1,0		79	79,00,2,8		129	128,904,5		179	178,906,3		229	228,908,0		279	278,809,8	
30	30,00,1,1		80	80,00,2,8		130	129,904,6		180	179,906,3		230	229,908,1		280	279,809,8	
31	31,00,1,1		81	81,00,2,8		131	130,904,6		181	180,906,3		231	230,908,1		281	280,809,8	
32	32,00,1,1		82	81,902,9		132	131,904,6		182	181,906,4		232	231,908,1		282	281,809,9	
33	33,00,1,2		83	82,902,9		133	132,904,7		183	182,906,4		233	232,908,2		283	282,809,9	
34	34,00,1,2		84	83,902,9		134	133,904,7		184	183,906,4		234	233,908,2		284	283,809,9	
35	35,00,1,2		85	84,903,0		135	134,904,7		185	184,906,5		235	234,908,2		285	284,810,0	
36	36,00,1,3		86	85,903,0		136	135,904,8		186	185,906,5		236	235,908,3		286	285,810,0	
37	37,00,1,3		87	86,903,0		137	136,904,8		187	186,906,5		237	236,908,3		287	286,810,0	
38	38,00,1,3		88	87,903,1		138	137,904,8		188	187,906,6		238	237,908,3		288	287,810,1	
39	39,00,1,4		89	88,903,1		139	138,904,9		189	188,906,6		239	238,908,4		289	288,810,1	
40	40,00,1,4		90	89,903,1		140	139,904,9		190	189,906,7		240	239,908,4		290	289,810,2	
41	41,00,1,4		91	90,903,2		141	140,904,9		191	190,906,7		241	240,908,4		291	290,810,2	
42	42,00,1,5		92	91,903,2		142	141,905,0		192	191,906,7		242	241,908,5		292	291,810,2	
43	43,00,1,5		93	92,903,2		143	142,905,0		193	192,906,8		243	242,908,5		293	292,810,3	
44	44,00,1,5		94	93,903,3		144	143,905,0		194	193,906,8		244	243,908,5		294	293,810,3	
45	45,00,1,6		95	94,903,3		145	144,905,1		195	194,906,8		245	244,908,6		295	294,810,3	
46	46,00,1,6		96	95,903,4		146	145,905,1		196	195,906,9		246	245,908,6		296	295,810,4	
47	47,00,1,6		97	96,903,4		147	146,905,1		197	196,906,9		247	246,908,6		297	296,810,4	
48	48,00,1,7		98	97,903,4		148	147,905,2		198	197,906,9		248	247,908,7		298	297,810,4	
49	49,00,1,7		99	98,903,5		149	148,905,2		199	198,907,0		249	248,908,7		299	298,810,5	
50	50,00,1,7		100	99,903,5		150	149,905,2		200	199,907,0		250	249,908,7		300	299,810,5	
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 88 Deg.

3°. Difference of Latitude and Departure for 3 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	01,0	00,1	51	50,9	02,7	101	100,9	05,3	151	150,8	07,9	201	200,7	10,5	251	250,6	13,1
2	02,0	00,1	52	51,9	02,7	102	101,9	05,3	152	151,8	08,0	202	201,7	10,6	252	251,6	13,2
3	03,0	00,2	53	52,9	02,8	103	102,9	05,4	153	152,8	08,0	203	202,7	10,6	253	252,6	13,2
4	04,0	00,2	54	53,9	02,8	104	103,9	05,4	154	153,8	08,1	204	203,7	10,7	254	253,6	13,3
5	05,0	00,3	55	54,9	02,9	105	104,9	05,5	155	154,8	08,1	205	204,7	10,7	255	254,6	13,3
6	06,0	00,3	56	55,9	02,9	106	105,9	05,5	156	155,8	08,2	206	205,7	10,8	256	255,6	13,4
7	07,0	00,4	57	56,9	03,0	107	106,9	05,6	157	156,8	08,2	207	206,7	10,8	257	256,6	13,4
8	08,0	00,4	58	57,9	03,0	108	107,8	05,7	158	157,8	08,3	208	207,7	10,9	258	257,6	13,5
9	09,0	00,5	59	58,9	03,1	109	108,8	05,7	159	158,8	08,3	209	208,7	10,9	259	258,6	13,6
10	10,0	00,5	60	59,9	03,1	110	109,8	05,8	160	159,8	08,4	210	209,7	11,0	260	259,6	13,6
11	11,0	00,6	61	60,9	03,2	111	110,8	05,8	161	160,8	08,4	211	210,7	11,0	261	260,6	13,7
22	12,0	00,6	62	61,9	03,2	112	111,8	05,9	162	161,8	08,5	212	211,7	11,1	262	261,6	13,7
13	13,0	00,7	63	62,9	03,3	113	112,8	05,9	163	162,8	08,5	213	212,7	11,1	263	262,6	13,8
14	14,0	00,7	64	63,9	03,3	114	113,8	06,0	164	163,8	08,6	214	213,7	11,2	264	263,6	13,8
15	15,0	00,8	65	64,9	03,4	115	114,8	06,0	165	164,8	08,6	215	214,7	11,2	265	264,6	13,9
16	16,0	00,8	66	65,9	03,5	116	115,8	06,1	166	165,8	08,7	216	215,7	11,3	266	265,6	13,9
17	17,0	00,9	67	66,9	03,5	117	116,8	06,1	167	166,8	08,7	217	216,7	11,4	267	266,6	14,0
18	18,0	00,9	68	67,9	03,6	118	117,8	06,2	168	167,8	08,8	218	217,7	11,4	268	267,6	14,0
19	19,0	01,0	69	68,9	03,6	119	118,8	06,2	169	168,8	08,8	219	218,7	11,5	269	268,6	14,1
20	20,0	01,0	70	69,9	03,7	120	119,8	06,3	170	169,8	08,9	220	219,7	11,5	270	269,6	14,1
21	21,0	01,1	71	70,9	03,7	121	120,8	06,3	171	170,8	09,0	221	220,7	11,6	271	270,6	14,2
22	22,0	01,1	72	71,9	03,8	122	121,8	06,4	172	171,8	09,0	222	221,7	11,6	272	271,6	14,2
23	23,0	01,2	73	72,9	03,8	123	122,8	06,4	173	172,8	09,1	223	222,7	11,7	273	272,6	14,3
24	24,0	01,3	74	73,9	03,9	124	123,8	06,5	174	173,8	09,1	224	223,7	11,7	274	273,6	14,3
25	25,0	01,3	75	74,9	03,9	125	124,8	06,5	175	174,8	09,2	225	224,7	11,8	275	274,6	14,4
26	26,0	01,4	76	75,9	04,0	126	125,8	06,6	176	175,8	09,2	226	225,7	11,8	276	275,6	14,4
27	27,0	01,4	77	76,9	04,0	127	126,8	06,6	177	176,8	09,3	227	226,7	11,9	277	276,6	14,5
28	28,0	01,5	78	77,9	04,1	128	127,8	06,7	178	177,8	09,3	228	227,7	11,9	278	277,6	14,5
29	29,0	01,5	79	78,9	04,1	129	128,8	06,8	179	178,7	09,4	229	228,7	12,0	279	278,6	14,6
30	30,0	01,6	80	79,9	04,2	130	129,8	06,8	180	179,7	09,4	230	229,7	12,0	280	279,6	14,7
31	31,0	01,6	81	80,9	04,2	131	130,8	06,9	181	180,7	09,5	231	230,7	12,1	281	280,6	14,7
32	32,0	01,7	82	81,9	04,3	132	131,8	06,9	182	181,7	09,5	232	231,7	12,1	282	281,6	14,8
33	33,0	01,7	83	82,9	04,3	133	132,8	07,0	183	182,7	09,6	233	232,7	12,2	283	282,6	14,8
34	34,0	01,8	84	83,9	04,4	134	133,8	07,0	184	183,7	09,6	234	233,7	12,2	284	283,6	14,9
35	35,0	01,8	85	84,9	04,4	135	134,8	07,1	185	184,7	09,7	235	234,7	12,3	285	284,6	14,9
36	36,0	01,9	86	85,9	04,5	136	135,8	07,1	186	185,7	09,7	236	235,7	12,3	286	285,6	15,0
37	36,9	01,9	87	86,9	04,6	137	136,8	07,2	187	186,7	09,8	237	236,7	12,4	287	286,6	15,0
38	37,9	02,0	88	87,9	04,6	138	137,8	07,2	188	187,7	09,8	238	237,7	12,5	288	287,6	15,1
39	38,9	02,0	89	88,9	04,7	139	138,8	07,3	189	188,7	09,9	239	238,7	12,5	289	288,6	15,1
40	39,9	02,1	90	89,9	04,7	140	139,8	07,3	190	189,7	09,9	240	239,7	12,6	290	289,6	15,2
41	40,9	02,1	91	90,9	04,8	141	140,8	07,4	191	190,7	10,0	241	240,7	12,6	291	290,6	15,2
42	41,9	02,2	92	91,9	04,8	142	141,8	07,4	192	191,7	10,0	242	241,7	12,7	292	291,6	15,3
43	42,9	02,2	93	92,9	04,9	143	142,8	07,5	193	192,7	10,1	243	242,7	12,7	293	292,6	15,3
44	43,9	02,3	94	93,9	04,9	144	143,8	07,5	194	193,7	10,1	244	243,7	12,8	294	293,6	15,4
45	44,9	02,4	95	94,9	05,0	145	144,8	07,6	195	194,7	10,2	245	244,7	12,8	295	294,6	15,4
46	45,9	02,4	96	95,9	05,0	146	145,8	07,6	196	195,7	10,3	246	245,7	12,9	296	295,6	15,5
47	46,9	02,5	97	96,9	05,1	147	146,8	07,7	197	196,7	10,3	247	246,7	12,9	297	296,6	15,5
48	47,9	02,5	98	97,9	05,1	148	147,8	07,7	198	197,7	10,4	248	247,7	13,0	298	297,6	15,6
49	48,9	02,6	99	98,9	05,2	149	148,8	07,8	199	198,7	10,4	249	248,7	13,0	299	298,6	15,6
50	49,9	02,6	100	99,9	05,2	150	149,8	07,9	200	199,7	10,5	250	249,7	13,1	300	299,6	15,7
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 87 Deg.

4°. Difference of Latitude and Departure for 4 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,1	51	50,9	03,6	101	100,8	07,0	151	150,6	10,5	201	200,5	14,0	251	250,4	17,5
2	02,0	00,1	52	51,9	03,6	102	101,8	07,1	152	151,6	10,6	202	201,5	14,1	252	251,4	17,6
3	03,0	00,2	53	52,9	03,7	103	102,8	07,2	153	152,6	10,7	203	202,5	14,1	253	252,4	17,6
4	04,0	00,3	54	53,9	03,8	104	103,8	07,2	154	153,6	10,7	204	203,5	14,2	254	253,4	17,7
5	05,0	00,3	55	54,9	03,8	105	104,7	07,3	155	154,6	10,8	205	204,5	14,3	255	254,4	17,8
6	06,0	00,4	56	55,9	03,9	106	105,7	07,4	156	155,6	10,9	206	205,5	14,4	256	255,4	17,8
7	07,0	00,5	57	56,9	04,0	107	106,7	07,5	157	156,6	10,9	207	206,5	14,4	257	256,4	17,9
8	08,0	00,6	58	57,9	04,0	108	107,7	07,5	158	157,6	11,0	208	207,5	14,5	258	257,4	18,0
9	09,0	00,6	59	58,9	04,1	109	108,7	07,6	159	158,6	11,1	209	208,5	14,6	259	258,4	18,1
10	10,0	00,7	60	59,9	04,2	110	109,7	07,7	160	159,6	11,2	210	209,5	14,6	260	259,4	18,1
11	11,0	00,8	61	60,9	04,3	111	110,7	07,7	161	160,6	11,2	211	210,5	14,7	261	260,4	18,2
12	12,0	00,8	62	61,9	04,3	112	111,7	07,8	162	161,6	11,3	212	211,5	14,8	262	261,4	18,3
13	13,0	00,9	63	62,8	04,4	113	112,7	07,9	163	162,6	11,4	213	212,5	14,8	263	262,4	18,3
14	14,0	01,0	64	63,8	04,5	114	113,7	07,9	164	163,6	11,4	214	213,5	14,9	264	263,4	18,4
15	15,0	01,0	65	64,8	04,5	115	114,7	08,0	165	164,6	11,5	215	214,5	15,0	265	264,4	18,5
16	16,0	01,1	66	65,8	04,6	116	115,7	08,1	166	165,6	11,6	216	215,5	15,1	266	265,4	18,5
17	17,0	01,2	67	66,8	04,7	117	116,7	08,2	167	166,6	11,6	217	216,5	15,1	267	266,4	18,6
18	18,0	01,3	68	67,8	04,7	118	117,7	08,2	168	167,6	11,7	218	217,5	15,2	268	267,4	18,7
19	19,0	01,3	69	68,8	04,8	119	118,7	08,3	169	168,6	11,8	219	218,5	15,3	269	268,4	18,7
20	20,0	01,4	70	69,8	04,9	120	119,7	08,4	170	169,6	11,8	220	219,5	15,3	270	269,4	18,8
21	20,9	01,5	71	70,8	05,0	121	120,7	08,4	171	170,6	11,9	221	220,5	15,4	271	270,3	18,9
22	21,9	01,5	72	71,8	05,0	122	121,7	08,5	172	171,6	12,0	222	221,5	15,5	272	271,3	19,0
23	22,9	01,6	73	72,8	05,1	123	122,7	08,6	173	172,6	12,1	223	222,5	15,5	273	272,3	19,0
24	23,9	01,7	74	73,8	05,2	124	123,7	08,6	174	173,6	12,1	224	223,5	15,6	274	273,3	19,1
25	24,9	01,7	75	74,8	05,2	125	124,7	08,7	175	174,6	12,2	225	224,5	15,7	275	274,3	19,2
26	25,9	01,8	76	75,8	05,3	126	125,7	08,8	176	175,6	12,3	226	225,5	15,8	276	275,3	19,2
27	26,9	01,9	77	76,8	05,4	127	126,7	08,9	177	176,6	12,3	227	226,5	15,8	277	276,3	19,3
28	27,9	02,0	78	77,8	05,4	128	127,7	08,9	178	177,6	12,4	228	227,5	15,9	278	277,3	19,4
29	28,9	02,0	79	78,8	05,5	129	128,7	09,0	179	178,6	12,5	229	228,5	16,0	279	278,3	19,4
30	29,9	02,1	80	79,8	05,6	130	129,7	09,1	180	179,6	12,5	230	229,4	16,0	280	279,3	19,5
31	30,9	02,2	81	80,8	05,7	131	130,7	09,1	181	180,6	12,6	231	230,4	16,1	281	280,3	19,6
32	31,9	02,2	82	81,8	05,7	132	131,7	09,2	182	181,6	12,7	232	231,4	16,2	282	281,3	19,7
33	32,9	02,3	83	82,8	05,8	133	132,7	09,3	183	182,6	12,8	233	232,4	16,2	283	282,3	19,7
34	33,9	02,4	84	83,8	05,9	134	133,7	09,3	184	183,6	12,8	234	233,4	16,3	284	283,3	19,8
35	34,9	02,4	85	84,8	05,9	135	134,7	09,4	185	184,6	12,9	235	234,4	16,4	285	284,3	19,9
36	35,9	02,5	86	85,8	06,0	136	135,7	09,5	186	185,6	13,0	236	235,4	16,4	286	285,3	19,9
37	36,9	02,6	87	86,8	06,1	137	136,7	09,5	187	186,6	13,0	237	236,4	16,5	287	286,3	20,0
38	37,9	02,7	88	87,8	06,1	138	137,7	09,6	188	187,5	13,1	238	237,4	16,6	288	287,3	20,1
39	38,9	02,7	89	88,8	06,2	139	138,7	09,7	189	188,5	13,2	239	238,4	16,7	289	288,3	20,1
40	39,9	02,8	90	89,8	06,3	140	139,7	09,8	190	189,5	13,2	240	239,4	16,7	290	289,3	20,2
41	40,9	02,9	91	90,8	06,4	141	140,7	09,8	191	190,5	13,3	241	240,4	16,8	291	290,3	20,3
42	41,9	02,9	92	91,8	06,4	142	141,7	09,9	192	191,5	13,4	242	241,4	16,9	292	291,3	20,4
43	42,9	03,0	93	92,8	06,5	143	142,7	10,0	193	192,5	13,5	243	242,4	16,9	293	292,3	20,4
44	43,9	03,1	94	93,8	06,6	144	143,7	10,0	194	193,5	13,5	244	243,4	17,0	294	293,3	20,5
45	44,9	03,1	95	94,8	06,6	145	144,7	10,1	195	194,5	13,6	245	244,4	17,1	295	294,3	20,6
46	45,9	03,2	96	95,8	06,7	146	145,6	10,2	196	195,5	13,7	246	245,4	17,1	296	295,3	20,6
47	46,9	03,3	97	96,8	06,8	147	146,6	10,2	197	196,5	13,7	247	246,4	17,2	297	296,3	20,7
48	47,9	03,4	98	97,8	06,8	148	147,6	10,3	198	197,5	13,8	248	247,4	17,3	298	297,3	20,8
49	48,9	03,4	99	98,8	06,9	149	148,6	10,4	199	198,5	13,9	249	248,4	17,4	299	298,3	20,8
50	49,9	03,5	100	99,8	07,0	150	149,6	10,5	200	199,5	13,9	250	249,4	17,4	300	299,3	20,9
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 86 Deg.

5. Difference of Latitude and Departure for 5 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01,0	00,1	51	50,8	04,4	101	100,6	08,8	151	150,4	13,1	201	200,2	17,5	251	250,0	21,8
2	02,0	00,2	52	51,8	04,5	102	101,6	08,9	152	151,4	13,2	202	201,2	17,6	252	251,0	21,9
3	03,0	00,3	53	52,8	04,6	103	102,6	09,0	153	152,4	13,3	203	202,2	17,7	253	252,0	22,0
4	04,0	00,3	54	53,8	04,7	104	103,6	09,0	154	153,4	13,4	204	203,2	17,7	254	253,0	22,1
5	05,0	00,4	55	54,8	04,8	105	104,6	09,1	155	154,4	13,5	205	204,2	17,8	255	254,0	22,2
6	06,0	00,5	56	55,8	04,9	106	105,6	09,2	156	155,4	13,6	206	205,2	17,9	256	255,0	22,3
7	07,0	00,6	57	56,8	05,0	107	106,6	09,3	157	156,4	13,7	207	206,2	18,0	257	256,0	22,4
8	08,0	00,7	58	57,8	05,1	108	107,6	09,4	158	157,4	13,7	208	207,2	18,1	258	257,0	22,4
9	09,0	00,8	59	58,8	05,1	109	108,6	09,5	159	158,4	13,8	209	208,2	18,2	259	258,0	22,5
10	10,0	00,9	60	59,8	05,2	110	109,6	09,6	160	159,4	13,9	210	209,2	18,3	260	259,0	22,6
11	11,0	01,0	61	60,8	05,3	111	110,6	09,7	161	160,4	14,0	211	210,2	18,4	261	260,0	22,7
12	12,0	01,0	62	61,8	05,4	112	111,6	09,7	162	161,4	14,1	212	211,2	18,4	262	261,0	22,8
13	12,9	01,1	63	62,8	05,5	113	112,6	09,8	163	162,4	14,2	213	212,2	18,5	263	262,0	22,9
14	13,9	01,2	64	63,8	05,6	114	113,6	09,9	164	163,4	14,3	214	213,2	18,6	264	263,0	23,0
15	14,9	01,3	65	64,8	05,7	115	114,6	10,0	165	164,4	14,4	215	214,2	18,7	265	264,0	23,1
16	15,9	01,4	66	65,7	05,8	116	115,6	10,1	166	165,4	14,4	216	215,2	18,8	266	265,0	23,1
17	16,9	01,5	67	66,7	05,8	117	116,6	10,2	167	166,4	14,5	217	216,2	18,9	267	266,0	23,2
18	17,9	01,6	68	67,7	05,9	118	117,6	10,3	168	167,4	14,6	218	217,2	19,0	268	267,0	23,3
19	18,9	01,7	69	68,7	06,0	119	118,5	10,4	169	168,4	14,7	219	218,2	19,1	269	268,0	23,4
20	19,9	01,7	70	69,7	06,1	120	119,5	10,5	170	169,4	14,8	220	219,2	19,1	270	269,0	23,5
21	20,9	01,8	71	70,7	06,2	121	120,5	10,5	171	170,4	14,9	221	220,2	19,2	271	270,0	23,6
22	21,9	01,9	72	71,7	06,3	122	121,5	10,6	172	171,3	15,0	222	221,2	19,3	272	271,0	23,7
23	22,9	02,0	73	72,7	06,4	123	122,5	10,7	173	172,3	15,1	223	222,2	19,4	273	272,0	23,8
24	23,9	02,1	74	73,7	06,5	124	123,5	10,8	174	173,3	15,1	224	223,1	19,5	274	273,0	23,8
25	24,9	02,2	75	74,7	06,5	125	124,5	10,9	175	174,3	15,2	225	224,1	19,6	275	274,0	23,9
26	25,9	02,3	76	75,7	06,6	126	125,5	11,0	176	175,3	15,3	226	225,1	19,7	276	275,0	24,0
27	26,9	02,4	77	76,7	06,7	127	126,5	11,0	177	176,3	15,4	227	226,1	19,7	277	275,9	24,1
28	27,9	02,4	78	77,7	06,8	128	127,5	11,1	178	177,3	15,5	228	227,1	19,8	278	276,9	24,2
29	28,9	02,5	79	78,7	06,9	129	128,5	11,2	179	178,3	15,6	229	228,1	19,9	279	277,9	24,3
30	29,9	02,6	80	79,7	07,0	130	129,5	11,3	180	179,3	15,7	230	229,1	20,0	280	278,9	24,4
31	30,9	02,7	81	80,7	07,1	131	130,5	11,4	181	180,3	15,7	231	230,1	20,1	281	279,9	24,4
32	31,9	02,8	82	81,7	07,2	132	131,5	11,5	182	181,3	15,8	232	231,1	20,2	282	280,9	24,5
33	32,9	02,9	83	82,7	07,2	133	132,5	11,6	183	182,3	15,9	233	232,1	20,3	283	281,9	24,6
34	33,9	03,0	84	83,7	07,3	134	133,5	11,7	184	183,3	16,0	234	233,1	20,4	284	282,9	24,7
35	34,9	03,1	85	84,7	07,4	135	134,5	11,7	185	184,3	16,1	235	234,1	20,4	285	283,9	24,8
36	35,9	03,1	86	85,7	07,5	136	135,5	11,8	186	185,3	16,2	236	235,1	20,5	286	284,9	24,9
37	36,9	03,2	87	86,7	07,6	137	136,5	11,9	187	186,3	16,3	237	236,1	20,6	287	285,9	25,0
38	37,9	03,3	88	87,7	07,7	138	137,5	12,0	188	187,3	16,4	238	237,1	20,7	288	286,9	25,1
39	38,9	03,4	89	88,7	07,8	139	138,5	12,1	189	188,3	16,4	239	238,1	20,8	289	287,9	25,1
40	39,8	03,5	90	89,7	07,8	140	139,5	12,2	190	189,3	16,5	240	239,1	20,9	290	288,9	25,2
41	40,8	03,6	91	90,7	07,9	141	140,5	12,3	191	190,3	16,6	241	240,1	21,0	291	289,9	25,3
42	41,8	03,7	92	91,6	08,0	142	141,5	12,4	192	191,3	16,7	242	241,1	21,1	292	290,9	25,4
43	42,8	03,8	93	92,6	08,1	143	142,5	12,4	193	192,3	16,8	243	242,1	21,1	293	291,9	25,5
44	43,8	03,8	94	93,6	08,2	144	143,5	12,5	194	193,3	16,9	244	243,1	21,2	294	292,9	25,6
45	44,8	03,9	95	94,6	08,3	145	144,4	12,6	195	194,3	17,0	245	244,1	21,3	295	293,9	25,7
46	45,8	04,0	96	95,6	08,4	146	145,4	12,7	196	195,3	17,1	246	245,1	21,4	296	294,9	25,8
47	46,8	04,1	97	96,6	08,5	147	146,4	12,8	197	196,3	17,1	247	246,1	21,5	297	295,9	25,8
48	47,8	04,2	98	97,6	08,5	148	147,4	12,9	198	197,2	17,2	248	247,1	21,6	298	296,9	25,9
49	48,8	04,3	99	98,6	08,6	149	148,4	13,0	199	198,2	17,3	249	248,1	21,7	299	297,9	26,0
50	49,8	04,4	100	99,6	08,7	150	149,4	13,1	200	199,2	17,4	250	249,1	21,8	300	298,9	26,1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 85 Deg.

6°. Difference of Latitude and Departure for 6 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,1	51	50,7	05,3	101	100,4	10,6	151	150,2	15,8	201	199,9	21,0	251	249,6	26,2
2	02,0	00,2	52	51,7	05,4	102	101,4	10,7	152	151,2	15,9	202	200,9	21,1	252	250,6	26,3
3	03,0	00,3	53	52,7	05,5	103	102,4	10,8	153	152,2	16,0	203	201,9	21,2	253	251,6	26,4
4	04,0	00,4	54	53,7	05,6	104	103,4	10,9	154	153,2	16,1	204	202,9	21,3	254	252,6	26,5
5	05,0	00,5	55	54,7	05,7	105	104,4	11,0	155	154,1	16,2	205	203,9	21,4	255	253,6	26,6
6	06,0	00,6	56	55,7	05,9	106	105,4	11,1	156	155,1	16,3	206	204,9	21,5	256	254,6	26,8
7	07,0	00,7	57	56,7	06,0	107	106,4	11,2	157	156,1	16,4	207	205,9	21,6	257	255,6	26,9
8	08,0	00,8	58	57,7	06,1	108	107,4	11,3	158	157,1	16,5	208	206,9	21,7	258	256,6	27,0
9	08,9	00,9	59	58,7	06,2	109	108,4	11,4	159	158,1	16,6	209	207,9	21,8	259	257,6	27,1
10	09,9	01,0	60	59,7	06,3	110	109,4	11,5	160	159,1	16,7	210	208,9	21,9	260	258,6	27,2
11	10,9	01,1	61	60,7	06,4	111	110,4	11,6	161	160,1	16,8	211	209,8	22,0	261	259,6	27,3
12	11,9	01,3	62	61,7	06,5	112	111,4	11,7	162	161,1	16,9	212	210,8	22,2	262	260,6	27,4
13	12,9	01,4	63	62,7	06,6	113	112,4	11,8	163	162,1	17,0	213	211,8	22,3	263	261,6	27,5
14	13,9	01,5	64	63,6	06,7	114	113,4	11,9	164	163,1	17,1	214	212,8	22,4	264	262,5	27,6
15	14,9	01,6	65	64,6	06,8	115	114,4	12,0	165	164,1	17,2	215	213,8	22,5	265	263,5	27,7
16	15,9	01,7	66	65,6	06,9	116	115,4	12,1	166	165,1	17,3	216	214,8	22,6	266	264,5	27,8
17	16,9	01,8	67	66,6	07,0	117	116,4	12,2	167	166,1	17,5	217	215,8	22,7	267	265,5	27,9
18	17,9	01,9	68	67,6	07,1	118	117,4	12,3	168	167,1	17,6	218	216,8	22,8	268	266,5	28,0
19	18,9	02,0	69	68,6	07,2	119	118,3	12,4	169	168,1	17,7	219	217,8	22,9	269	267,5	28,1
20	19,9	02,1	70	69,6	07,3	120	119,3	12,5	170	169,1	17,8	220	218,8	23,0	270	268,5	28,2
21	20,9	02,2	71	70,6	07,4	121	120,3	12,6	171	170,1	17,9	221	219,8	23,1	271	269,5	28,3
22	21,9	02,3	72	71,6	07,5	122	121,3	12,7	172	171,1	18,0	222	220,8	23,2	272	270,5	28,4
23	22,9	02,4	73	72,6	07,6	123	122,3	12,9	173	172,0	18,1	223	221,8	23,3	273	271,5	28,5
24	23,9	02,5	74	73,6	07,7	124	123,3	13,0	174	173,0	18,2	224	222,8	23,4	274	272,5	28,6
25	24,9	02,6	75	74,6	07,8	125	124,3	13,1	175	174,0	18,3	225	223,8	23,5	275	273,5	28,7
26	25,9	02,7	76	75,6	07,9	126	125,3	13,2	176	175,0	18,4	226	224,8	23,6	276	274,5	28,8
27	26,9	02,8	77	76,6	08,0	127	126,3	13,3	177	176,0	18,5	227	225,8	23,7	277	275,5	28,9
28	27,8	02,9	78	77,6	08,1	128	127,3	13,4	178	177,0	18,6	228	226,7	23,8	278	276,5	29,1
29	28,8	03,0	79	78,6	08,3	129	128,3	13,5	179	178,0	18,7	229	227,7	23,9	279	277,5	29,2
30	29,8	03,1	80	79,6	08,4	130	129,3	13,6	180	179,0	18,8	230	228,7	24,0	280	278,5	29,3
31	30,8	03,2	81	80,6	08,5	131	130,3	13,7	181	180,0	18,9	231	229,7	24,1	281	279,5	29,4
32	31,8	03,3	82	81,5	08,6	132	131,3	13,8	182	181,0	19,0	232	230,7	24,2	282	280,4	29,5
33	32,8	03,4	83	82,5	08,7	133	132,3	13,9	183	182,0	19,1	233	231,7	24,3	283	281,4	29,6
34	33,8	03,6	84	83,5	08,8	134	133,3	14,0	184	183,0	19,2	234	232,7	24,5	284	282,4	29,7
35	34,8	03,7	85	84,5	08,9	135	134,3	14,1	185	184,0	19,3	235	233,7	24,6	285	283,4	29,8
36	35,8	03,8	86	85,5	09,0	136	135,3	14,2	186	185,0	19,4	236	234,7	24,7	286	284,4	29,9
37	36,8	03,9	87	86,5	09,1	137	136,2	14,3	187	186,0	19,5	237	235,7	24,8	287	285,4	30,0
38	37,8	04,0	88	87,5	09,2	138	137,2	14,4	188	187,0	19,6	238	236,7	24,9	288	286,4	30,1
39	38,8	04,1	89	88,5	09,3	139	138,2	14,5	189	188,0	19,8	239	237,7	25,0	289	287,4	30,2
40	39,8	04,2	90	89,5	09,4	140	139,2	14,6	190	189,0	19,9	240	238,7	25,1	290	288,4	30,3
41	40,8	04,3	91	90,5	09,5	141	140,2	14,7	191	189,9	20,0	241	239,7	25,2	291	289,4	30,4
42	41,8	04,4	92	91,5	09,6	142	141,2	14,8	192	190,9	20,1	242	240,7	25,3	292	290,4	30,5
43	42,8	04,5	93	92,5	09,7	143	142,2	14,9	193	191,9	20,2	243	241,7	25,4	293	291,4	30,6
44	43,8	04,6	94	93,5	09,8	144	143,2	15,0	194	192,9	20,3	244	242,7	25,5	294	292,4	30,7
45	44,8	04,7	95	94,5	09,9	145	144,2	15,2	195	193,9	20,4	245	243,7	25,6	295	293,4	30,8
46	45,7	04,8	96	95,5	10,0	146	145,2	15,3	196	194,9	20,5	246	244,6	25,7	296	294,4	30,9
47	46,7	04,9	97	96,5	10,1	147	146,2	15,4	197	195,9	20,6	247	245,6	25,8	297	295,4	31,0
48	47,7	05,0	98	97,5	10,2	148	147,2	15,5	198	196,9	20,7	248	246,6	25,9	298	296,4	31,1
49	48,7	05,1	99	98,5	10,3	149	148,2	15,6	199	197,9	20,8	249	247,6	26,0	299	297,4	31,2
50	49,7	05,2	100	99,5	10,5	150	149,2	15,7	200	198,9	20,9	250	248,6	26,1	300	298,4	31,4
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 84 Deg.

7°. Difference of Latitude and Departure for 7 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,1	51	50,6	06,2	101	100,2	12,3	151	149,9	18,4	201	199,5	24,5	251	249,1	30,6
2	02,0	00,2	52	51,6	06,3	102	101,2	12,4	152	150,9	18,5	202	200,5	24,6	252	250,1	30,7
3	03,0	00,4	53	52,6	06,5	103	102,2	12,5	153	151,9	18,6	203	201,5	24,7	253	251,1	30,8
4	04,0	00,5	54	53,6	06,6	104	103,2	12,7	154	152,8	18,7	204	202,5	24,8	254	252,1	30,9
5	05,0	00,6	55	54,6	06,7	105	104,2	12,8	155	153,8	18,9	205	203,5	25,0	255	253,1	31,0
6	06,0	00,7	56	55,6	06,8	106	105,2	12,9	156	154,8	19,0	206	204,5	25,1	256	254,1	31,2
7	06,9	00,9	57	56,6	06,9	107	106,2	13,0	157	155,8	19,1	207	205,4	25,2	257	255,1	31,3
8	07,9	01,0	58	57,6	07,1	108	107,2	13,1	158	156,8	19,2	208	206,4	25,3	258	256,1	31,4
9	08,9	01,1	59	58,6	07,2	109	108,2	13,3	159	157,8	19,4	209	207,4	25,4	259	257,1	31,5
10	09,9	01,2	60	59,6	07,3	110	109,2	13,4	160	158,8	19,5	210	208,4	25,6	260	258,1	31,7
11	10,9	01,3	61	60,5	07,4	111	110,2	13,5	161	159,8	19,6	211	209,4	25,7	261	259,0	31,8
12	11,9	01,5	62	61,5	07,5	112	111,2	13,6	162	160,8	19,7	212	210,4	25,8	262	260,0	31,9
13	12,9	01,6	63	62,5	07,7	113	112,2	13,8	163	161,8	19,8	213	211,4	25,9	263	261,0	32,0
14	13,9	01,7	64	63,5	07,8	114	113,1	13,9	164	162,8	20,0	214	212,4	26,1	264	262,0	32,1
15	14,9	01,8	65	64,5	07,9	115	114,1	14,0	165	163,8	20,1	215	213,4	26,2	265	263,0	32,3
16	15,9	01,9	66	65,5	08,0	116	115,1	14,1	166	164,8	20,2	216	214,4	26,3	266	264,0	32,4
17	16,9	02,1	67	66,5	08,2	117	116,1	14,2	167	165,7	20,3	217	215,4	26,4	267	265,0	32,5
18	17,9	02,2	68	67,5	08,3	118	117,1	14,4	168	166,7	20,5	218	216,4	26,5	268	266,0	32,6
19	18,9	02,3	69	68,5	08,4	119	118,1	14,5	169	167,7	20,6	219	217,4	26,7	269	267,0	32,8
20	19,9	02,4	70	69,5	08,5	120	119,1	14,6	170	168,7	20,7	220	218,4	26,8	270	268,0	32,9
21	20,8	02,6	71	70,5	08,6	121	120,1	14,7	171	169,7	20,8	221	219,3	26,9	271	269,0	33,0
22	21,8	02,7	72	71,5	08,8	122	121,1	14,9	172	170,7	20,9	222	220,3	27,0	272	270,0	33,1
23	22,8	02,8	73	72,5	08,9	123	122,1	15,0	173	171,7	21,1	223	221,3	27,2	273	271,0	33,2
24	23,8	02,9	74	73,4	09,0	124	123,1	15,1	174	172,7	21,2	224	222,3	27,3	274	271,9	33,4
25	24,8	03,0	75	74,4	09,1	125	124,1	15,2	175	173,7	21,3	225	223,3	27,4	275	272,9	33,5
26	25,8	03,2	76	75,4	09,3	126	125,1	15,3	176	174,7	21,4	226	224,3	27,5	276	273,9	33,6
27	26,8	03,3	77	76,4	09,4	127	126,0	15,5	177	175,7	21,6	227	225,3	27,6	277	274,9	33,7
28	27,8	03,4	78	77,4	09,5	128	127,0	15,6	178	176,7	21,7	228	226,3	27,8	278	275,9	33,9
29	28,8	03,5	79	78,4	09,6	129	128,0	15,7	179	177,7	21,8	229	227,3	27,9	279	276,9	34,0
30	29,8	03,7	80	79,4	09,7	130	129,0	15,8	180	178,7	21,9	230	228,3	28,0	280	277,9	34,1
31	30,8	03,8	81	80,4	09,9	131	130,0	16,0	181	179,6	22,0	231	229,3	28,1	281	278,9	34,2
32	31,8	03,9	82	81,4	10,0	132	131,0	16,1	182	180,6	22,2	232	230,3	28,3	282	279,9	34,3
33	32,8	04,0	83	82,4	10,1	133	132,0	16,2	183	181,6	22,3	233	231,3	28,4	283	280,9	34,5
34	33,7	04,1	84	83,4	10,2	134	133,0	16,3	184	182,6	22,4	234	232,2	28,5	284	281,9	34,6
35	34,7	04,3	85	84,4	10,4	135	134,0	16,4	185	183,6	22,5	235	233,2	28,6	285	282,9	34,7
36	35,7	04,4	86	85,4	10,5	136	135,0	16,6	186	184,6	22,7	236	234,2	28,7	286	283,9	34,8
37	36,7	04,5	87	86,3	10,6	137	136,0	16,7	187	185,6	22,8	237	235,2	28,9	287	284,8	34,9
38	37,7	04,6	88	87,3	10,7	138	137,0	16,8	188	186,6	22,9	238	236,2	29,0	288	285,8	35,1
39	38,7	04,8	89	88,3	10,8	139	138,0	16,9	189	187,6	23,0	239	237,2	29,1	289	286,8	35,2
40	39,7	04,9	90	89,3	11,0	140	139,0	17,1	190	188,6	23,1	240	238,2	29,2	290	287,8	35,3
41	40,7	05,0	91	90,3	11,1	141	139,9	17,2	191	189,6	23,3	241	239,2	29,3	291	288,8	35,4
42	41,7	05,1	92	91,3	11,2	142	140,9	17,3	192	190,6	23,4	242	240,2	29,5	292	289,8	35,5
43	42,7	05,2	93	92,3	11,3	143	141,9	17,4	193	191,6	23,5	243	241,2	29,6	293	290,8	35,7
44	43,7	05,4	94	93,3	11,5	144	142,9	17,5	194	192,5	23,6	244	242,2	29,7	294	291,8	35,8
45	44,7	05,5	95	94,3	11,6	145	143,9	17,7	195	193,5	23,7	245	243,2	29,8	295	292,8	35,9
46	45,7	05,6	96	95,3	11,7	146	144,9	17,8	196	194,5	23,9	246	244,1	29,9	296	293,8	36,0
47	46,6	05,7	97	96,3	11,8	147	145,9	17,9	197	195,5	24,0	247	245,1	30,1	297	294,8	36,2
48	47,6	05,8	98	97,3	11,9	148	146,9	18,0	198	196,5	24,1	248	246,1	30,2	298	295,8	36,3
49	48,6	06,0	99	98,3	12,1	149	147,9	18,1	199	197,5	24,2	249	247,1	30,3	299	296,8	36,5
50	49,6	06,1	100	99,3	12,2	150	148,9	18,3	200	198,5	24,4	250	248,1	30,4	300	297,8	36,6
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 83 Deg.

8°. Difference of Latitude and Departure for 8 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,1	51	50,5	07,1	101	100,0	14,1	151	149,5	21,0	201	199,1	28,0	251	248,6	34,9
2	02,0	00,3	52	51,5	07,2	102	101,0	14,2	152	150,5	21,2	202	200,0	28,1	252	249,6	35,1
3	03,0	00,4	53	52,5	07,4	103	102,0	14,3	153	151,5	21,3	203	201,0	28,3	253	250,5	35,2
4	04,0	00,6	54	53,5	07,5	104	103,0	14,5	154	152,5	21,4	204	202,0	28,4	254	251,5	35,4
5	05,0	00,7	55	54,5	07,7	105	104,0	14,6	155	153,5	21,6	205	203,0	28,5	255	252,5	35,5
6	05,9	00,8	56	55,5	07,8	106	105,0	14,8	156	154,5	21,7	206	204,0	28,7	256	253,5	35,6
7	06,9	01,0	57	56,4	07,9	107	106,0	14,9	157	155,5	21,9	207	205,0	28,8	257	254,5	35,8
8	07,9	01,1	58	57,4	08,1	108	107,0	15,0	158	156,5	22,0	208	206,0	29,0	258	255,5	35,9
9	08,9	01,3	59	58,4	08,2	109	107,9	15,2	159	157,5	22,1	209	207,0	29,1	259	256,5	36,1
10	09,9	01,4	60	59,4	08,4	110	108,9	15,3	160	158,4	22,3	210	208,0	29,2	260	257,5	36,2
11	10,9	01,5	61	60,4	08,5	111	109,9	15,5	161	159,4	22,4	211	209,0	29,4	261	258,5	36,3
12	11,9	01,7	62	61,4	08,6	112	110,9	15,6	162	160,4	22,6	212	209,9	29,5	262	259,5	36,5
13	12,9	01,8	63	62,4	08,8	113	111,9	15,7	163	161,4	22,7	213	210,9	29,6	263	260,4	36,6
14	13,9	01,9	64	63,4	08,9	114	112,9	15,9	164	162,4	22,8	214	211,9	29,8	264	261,4	36,7
15	14,9	02,1	65	64,4	09,0	115	113,9	16,0	165	163,4	23,0	215	212,9	29,9	265	262,4	36,9
16	15,8	02,2	66	65,4	09,2	116	114,9	16,1	166	164,4	23,1	216	213,9	30,1	266	263,4	37,0
17	16,8	02,4	67	66,4	09,3	117	115,9	16,3	167	165,4	23,2	217	214,9	30,2	267	264,4	37,2
18	17,8	02,5	68	67,3	09,5	118	116,9	16,4	168	166,4	23,4	218	215,9	30,3	268	265,4	37,3
19	18,8	02,6	69	68,3	09,6	119	117,8	16,6	169	167,4	23,5	219	216,9	30,5	269	266,4	37,4
20	19,8	02,8	70	69,3	09,7	120	118,8	16,7	170	168,4	23,7	220	217,9	30,6	270	267,4	37,6
21	20,8	02,9	71	70,3	09,9	121	119,8	16,8	171	169,3	23,8	221	218,9	30,8	271	268,4	37,7
22	21,8	03,1	72	71,3	10,0	122	120,8	17,0	172	170,3	23,9	222	219,8	30,9	272	269,4	37,9
23	22,8	03,2	73	72,3	10,2	123	121,8	17,1	173	171,3	24,1	223	220,8	31,0	273	270,4	38,0
24	23,8	03,3	74	73,3	10,3	124	122,8	17,3	174	172,3	24,2	224	221,8	31,2	274	271,3	38,1
25	24,8	03,5	75	74,3	10,4	125	123,8	17,4	175	173,3	24,4	225	222,8	31,3	275	272,3	38,3
26	25,7	03,6	76	75,3	10,6	126	124,8	17,5	176	174,3	24,5	226	223,8	31,5	276	273,3	38,4
27	26,7	03,8	77	76,3	10,7	127	125,8	17,7	177	175,3	24,6	227	224,8	31,6	277	274,3	38,6
28	27,7	03,9	78	77,2	10,9	128	126,8	17,8	178	176,3	24,8	228	225,8	31,7	278	275,3	38,7
29	28,7	04,0	79	78,2	11,0	129	127,7	18,0	179	177,3	24,9	229	226,8	31,9	279	276,3	38,8
30	29,7	04,2	80	79,2	11,1	130	128,7	18,1	180	178,3	25,1	230	227,8	32,0	280	277,3	39,0
31	30,7	04,3	81	80,2	11,3	131	129,7	18,2	181	179,2	25,2	231	228,8	32,2	281	278,3	39,1
32	31,7	04,5	82	81,2	11,4	132	130,7	18,4	182	180,2	25,3	232	229,7	32,3	282	279,3	39,3
33	32,7	04,6	83	82,2	11,6	133	131,7	18,5	183	181,2	25,5	233	230,7	32,4	283	280,3	39,4
34	33,7	04,7	84	83,2	11,7	134	132,7	18,7	184	182,2	25,6	234	231,7	32,6	284	281,2	39,5
35	34,7	04,9	85	84,2	11,8	135	133,7	18,8	185	183,2	25,8	235	232,7	32,7	285	282,2	39,7
36	35,7	05,0	86	85,2	12,0	136	134,7	18,9	186	184,2	25,9	236	233,7	32,9	286	283,2	39,8
37	36,6	05,2	87	86,2	12,1	137	135,7	19,1	187	185,2	26,0	237	234,7	33,0	287	284,2	40,0
38	37,6	05,3	88	87,1	12,2	138	136,7	19,2	188	186,2	26,2	238	235,7	33,1	288	285,2	40,1
39	38,6	05,4	89	88,1	12,4	139	137,7	19,3	189	187,2	26,3	239	236,7	33,3	289	286,2	40,2
40	39,6	05,6	90	89,1	12,5	140	138,6	19,5	190	188,2	26,4	240	237,7	33,4	290	287,2	40,4
41	40,6	05,7	91	90,1	12,7	141	139,6	19,6	191	189,2	26,6	241	238,7	33,5	291	288,2	40,5
42	41,6	05,8	92	91,1	12,8	142	140,6	19,8	192	190,1	26,7	242	239,7	33,7	292	289,2	40,6
43	42,6	06,0	93	92,1	12,9	143	141,6	19,9	193	191,1	26,9	243	240,6	33,8	293	290,2	40,8
44	43,6	06,1	94	93,1	13,1	144	142,6	20,0	194	192,1	27,0	244	241,6	34,0	294	291,1	40,9
45	44,6	06,3	95	94,1	13,2	145	143,6	20,2	195	193,1	27,1	245	242,6	34,1	295	292,1	41,1
46	45,6	06,2	96	95,1	13,4	146	144,6	20,3	196	194,1	27,3	246	243,6	34,2	296	293,1	41,2
47	46,5	06,3	97	96,1	13,5	147	145,6	20,5	197	195,1	27,4	247	244,6	34,4	297	294,1	41,3
48	47,5	06,4	98	97,0	13,6	148	146,6	20,6	198	196,1	27,6	248	245,6	34,5	298	295,1	41,5
49	48,5	06,4	99	98,0	13,8	149	147,6	20,7	199	197,1	27,7	249	246,6	34,7	299	296,1	41,6
50	49,5	07,0	100	99,0	13,9	150	148,5	20,9	200	198,1	27,8	250	247,6	34,8	300	297,1	41,8
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 82 Deg.

9°. Difference of Latitude and Departure for 9 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01,0	00,2	51	50,4	08,0	101	99,8	15,8	151	149,1	23,6	201	198,5	31,4	251	247,9	39,3
2	02,0	00,3	52	51,4	08,1	102	100,7	16,0	152	150,1	23,8	202	199,5	31,6	252	248,9	39,4
3	03,0	00,5	53	52,3	08,3	103	101,7	16,1	153	151,1	23,9	203	200,5	31,7	253	249,9	39,6
4	04,0	00,6	54	53,3	08,4	104	102,7	16,3	154	152,1	24,1	204	201,5	31,9	254	250,9	39,7
5	04,9	00,8	55	54,3	08,6	105	103,7	16,4	155	153,1	24,2	205	202,5	32,1	255	251,9	39,9
6	05,9	00,9	56	55,3	08,8	106	104,7	16,6	156	154,1	24,4	206	203,5	32,2	256	252,9	40,0
7	06,9	01,1	57	56,3	08,9	107	105,7	16,7	157	155,1	24,6	207	204,5	32,4	257	253,8	40,2
8	07,9	01,3	58	57,3	09,1	108	106,7	16,9	158	156,1	24,7	208	205,4	32,5	258	254,8	40,4
9	08,9	01,4	59	58,3	09,2	109	107,7	17,0	159	157,0	24,9	209	206,4	32,7	259	255,8	40,5
10	09,9	01,6	60	59,3	09,4	110	108,6	17,2	160	158,0	25,0	210	207,4	32,8	260	256,8	40,7
11	10,9	01,7	61	60,2	09,5	111	109,6	17,4	161	159,0	25,2	211	208,4	33,0	261	257,8	40,8
12	11,9	01,9	62	61,2	09,7	112	110,6	17,5	162	160,0	25,3	212	209,4	33,2	262	258,8	41,0
13	12,9	02,0	63	62,2	09,9	113	111,6	17,7	163	161,0	25,5	213	210,4	33,3	263	259,8	41,1
14	13,8	02,2	64	63,2	10,0	114	112,6	18,8	164	162,0	25,6	214	211,4	33,5	264	260,8	41,3
15	14,8	02,3	65	64,2	10,2	115	113,6	18,0	165	163,0	25,8	215	212,4	33,6	265	261,7	41,4
16	15,8	02,5	66	65,2	10,3	116	114,6	18,1	166	164,0	26,0	216	213,3	33,8	266	262,7	41,6
17	16,8	02,7	67	66,2	10,5	117	115,6	18,3	167	164,9	26,1	217	214,3	33,9	267	263,7	41,8
18	17,8	02,8	68	67,2	10,6	118	116,5	18,5	168	165,9	26,3	218	215,3	34,1	268	264,7	41,9
19	18,8	03,0	69	68,2	10,8	119	117,5	18,6	169	166,9	26,4	219	216,3	34,3	269	265,7	42,1
20	19,8	03,1	70	69,1	10,9	120	118,5	18,8	170	167,9	26,6	220	217,3	34,4	270	266,7	42,2
21	20,7	03,3	71	70,1	11,1	121	119,5	18,9	171	168,9	26,7	221	218,3	34,6	271	267,7	42,4
22	21,7	03,4	72	71,1	11,3	122	120,5	19,1	172	169,9	26,9	222	219,3	34,7	272	268,7	42,5
23	22,7	03,6	73	72,1	11,4	123	121,5	19,2	173	170,9	27,1	223	220,3	34,9	273	269,6	42,7
24	23,7	03,8	74	73,1	11,6	124	122,5	19,4	174	171,9	27,2	224	221,2	35,0	274	270,6	42,9
25	24,7	03,9	75	74,1	11,7	125	123,5	19,6	175	172,8	27,3	225	222,4	35,2	275	271,6	43,0
26	25,7	04,1	76	75,1	11,9	126	124,5	19,7	176	173,8	27,5	226	223,2	35,3	276	272,6	43,2
27	26,7	04,2	77	76,1	12,0	127	125,4	19,9	177	174,8	27,7	227	224,2	35,5	277	273,6	43,3
28	27,7	04,4	78	77,0	12,2	128	126,4	20,0	178	175,8	27,8	228	225,2	35,7	278	274,6	43,5
29	28,6	04,5	79	78,0	12,4	129	127,4	20,2	179	176,8	28,0	229	226,2	35,8	279	275,6	43,6
30	29,6	04,7	80	79,0	12,5	130	128,4	20,3	180	177,8	28,2	230	227,2	36,0	280	276,6	43,8
31	30,6	04,8	81	80,0	12,7	131	129,4	20,5	181	178,8	28,3	231	228,2	36,1	281	277,5	43,9
32	31,6	05,0	82	81,0	12,8	132	130,4	20,6	182	179,8	28,5	232	229,1	36,3	282	278,5	44,1
33	32,6	05,2	83	82,0	13,0	133	131,4	20,8	183	180,7	28,6	233	230,1	36,4	283	279,5	44,3
34	33,6	05,3	84	83,0	13,1	134	132,4	21,0	184	181,7	28,8	234	231,1	36,6	284	280,5	44,4
35	34,6	05,5	85	84,0	13,3	135	133,3	21,1	185	182,7	28,9	235	232,1	36,8	285	281,5	44,6
36	35,6	05,6	86	84,9	13,5	136	134,3	21,3	186	183,7	29,1	236	233,1	36,9	286	282,5	44,7
37	36,5	05,8	87	85,9	13,6	137	135,3	21,4	187	184,7	29,2	237	234,1	37,1	287	283,5	44,9
38	37,5	05,9	88	86,9	13,8	138	136,3	21,6	188	185,7	29,4	238	235,1	37,2	288	284,5	45,0
39	38,5	06,1	89	87,9	13,9	139	137,3	21,7	189	186,7	29,6	239	236,1	37,4	289	285,4	45,2
40	39,5	06,3	90	88,9	14,1	140	138,3	21,9	190	187,7	29,7	240	237,0	37,5	290	286,4	45,4
41	40,5	06,4	91	89,9	14,2	141	139,3	22,1	191	188,7	29,9	241	238,0	37,7	291	287,4	45,5
42	41,5	06,6	92	90,9	14,4	142	140,3	22,2	192	189,6	30,0	242	239,0	37,8	292	288,4	45,7
43	42,5	06,7	93	91,9	14,5	143	141,2	22,4	193	190,6	30,2	243	240,0	38,0	293	289,4	45,8
44	43,5	06,9	94	92,8	14,7	144	142,2	22,5	194	191,6	30,3	244	241,0	38,2	294	290,4	46,0
45	44,4	07,0	95	93,8	14,9	145	143,2	22,7	195	192,6	30,5	245	242,0	38,3	295	291,4	46,1
46	45,4	07,2	96	94,8	15,0	146	144,2	22,8	196	193,6	30,7	246	243,0	38,5	296	292,4	46,3
47	46,4	07,4	97	95,8	15,2	147	145,2	23,0	197	194,6	30,8	247	244,0	38,6	297	293,3	46,5
48	47,4	07,5	98	96,8	15,3	148	146,2	23,1	198	195,6	31,0	248	244,9	38,8	298	294,3	46,6
49	48,4	07,7	99	97,8	15,5	149	147,2	23,3	199	196,6	31,1	249	245,9	38,9	299	295,3	46,8
50	49,4	07,8	100	98,8	15,6	150	148,2	23,5	200	197,5	31,3	250	246,9	39,1	300	296,3	46,9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 81 Deg.

10°. Difference of Latitude and Departure for 10 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01,0	00,2	51	50,2	08,8	101	99,5	17,5	151	148,7	26,2	201	197,9	34,9	251	247,2	43,5
2	02,0	00,3	52	51,2	09,0	102	100,4	17,7	152	149,7	26,4	202	198,9	35,0	252	248,2	43,7
3	03,0	00,5	53	52,2	09,2	103	101,4	17,9	153	150,7	26,5	203	199,9	35,2	253	249,2	43,9
4	03,9	00,7	54	53,2	09,4	104	102,4	18,0	154	151,7	26,7	204	200,9	35,4	254	250,1	44,0
5	04,9	00,9	55	54,2	09,5	105	103,4	18,2	155	152,6	26,9	205	201,9	35,5	255	251,1	44,2
6	05,9	01,0	56	55,1	09,7	106	104,4	18,4	156	153,6	27,1	206	202,9	35,7	256	252,1	44,4
7	06,9	01,2	57	56,1	09,9	107	105,4	18,6	157	154,6	27,2	207	203,9	35,9	257	253,1	44,6
8	07,9	01,4	58	57,1	10,1	108	106,4	18,7	158	155,6	27,4	208	204,8	36,1	258	254,1	44,7
9	08,9	01,6	59	58,1	10,2	109	107,3	18,9	159	156,6	27,6	209	205,8	36,2	259	255,1	44,9
10	09,8	01,7	60	59,1	10,4	110	108,3	19,1	160	157,6	27,7	210	206,8	36,4	260	256,0	45,1
11	10,8	01,9	61	60,1	10,6	111	109,3	19,2	161	158,6	27,9	211	207,8	36,6	261	257,0	45,3
12	11,8	02,1	62	61,1	10,8	112	110,3	19,4	162	159,5	28,1	212	208,8	36,8	262	258,0	45,4
13	12,8	02,3	63	62,0	10,9	113	111,3	19,6	163	160,5	28,3	213	209,8	36,9	263	259,0	45,6
14	13,8	02,4	64	63,0	11,1	114	112,3	19,8	164	161,5	28,4	214	210,7	37,1	264	260,0	45,8
15	14,8	02,6	65	64,0	11,2	115	113,3	19,9	165	162,5	28,6	215	211,7	37,3	265	261,0	46,0
16	15,8	02,8	66	65,0	11,4	116	114,2	20,1	166	163,5	28,8	216	212,7	37,5	266	262,0	46,1
17	16,7	02,9	67	66,0	11,6	117	115,2	20,3	167	164,5	29,0	217	213,7	37,6	267	262,9	46,3
18	17,7	03,1	68	67,0	11,8	118	116,2	20,5	168	165,4	29,1	218	214,7	37,8	268	263,9	46,5
19	18,7	03,3	69	68,0	12,0	119	117,2	20,6	169	166,4	29,3	219	215,7	38,0	269	264,9	46,6
20	19,7	03,5	70	68,9	12,1	120	118,2	20,8	170	167,4	29,5	220	216,7	38,1	270	265,9	46,8
21	20,7	03,6	71	69,9	12,3	121	119,2	21,0	171	168,4	29,7	221	217,6	38,3	271	266,9	47,0
22	21,7	03,8	72	70,9	12,5	122	120,1	21,2	172	169,4	29,8	222	218,6	38,5	272	267,9	47,2
23	22,7	04,0	73	71,9	12,7	123	121,1	21,3	173	170,4	30,0	223	219,6	38,7	273	268,8	47,3
24	23,6	04,2	74	72,9	12,8	124	122,1	21,5	174	171,4	30,2	224	220,6	38,8	274	279,8	47,5
25	24,6	04,3	75	73,9	13,0	125	123,1	21,7	175	172,3	30,3	225	221,6	39,0	275	270,8	47,7
26	25,6	04,5	76	74,8	13,2	126	124,1	21,8	176	173,3	30,5	226	222,6	39,2	276	271,8	47,9
27	26,6	04,7	77	75,8	13,4	127	125,1	22,0	177	174,3	30,7	227	223,5	39,4	277	272,8	48,0
28	27,6	04,9	78	76,8	13,5	128	126,1	22,2	178	175,3	30,9	228	224,5	39,5	278	273,8	48,2
29	28,6	05,0	79	77,8	13,7	129	127,0	22,4	179	176,3	31,0	229	225,5	39,7	279	274,8	48,4
30	29,5	05,2	80	78,8	13,9	130	128,0	22,5	180	177,3	31,2	230	226,5	39,9	280	275,7	48,6
31	30,5	05,4	81	79,8	14,0	131	129,0	22,7	181	178,2	31,4	231	227,5	40,1	281	276,7	48,7
32	31,5	05,5	82	80,8	14,2	132	130,0	22,9	182	179,2	31,6	232	228,5	40,2	282	277,7	48,9
33	32,5	05,7	83	81,7	14,4	133	131,0	23,1	183	180,2	31,7	233	229,5	40,4	283	278,7	49,1
34	33,5	05,9	84	82,7	14,6	134	132,0	23,2	184	181,2	31,9	234	230,4	40,6	284	279,7	49,2
35	34,5	06,1	85	83,7	14,7	135	132,9	23,4	185	182,2	32,1	235	231,4	40,7	285	280,7	49,4
36	35,5	06,2	86	84,7	14,9	136	133,9	23,6	186	183,2	32,3	236	232,4	40,9	286	281,6	49,6
37	36,4	06,4	87	85,7	15,1	137	134,9	23,8	187	184,2	32,4	237	233,4	41,1	287	282,6	49,8
38	37,4	06,6	88	86,7	15,3	138	135,9	23,9	188	185,1	32,6	238	234,4	41,3	288	283,6	49,9
39	38,4	06,8	89	87,6	15,4	139	136,9	24,1	189	186,1	32,8	239	235,4	41,4	289	284,6	50,1
40	39,4	06,9	90	88,6	15,6	140	137,9	24,3	190	187,1	32,9	240	236,3	41,6	290	285,6	50,3
41	40,4	07,1	91	89,6	15,8	141	138,9	24,4	191	188,1	33,1	241	237,3	41,8	291	286,6	50,5
42	41,4	07,3	92	90,6	16,0	142	139,8	24,6	192	189,1	33,3	242	238,3	42,0	292	287,6	50,6
43	42,3	07,5	93	91,6	16,1	143	140,8	24,8	193	190,1	33,5	243	239,3	42,1	293	288,5	50,8
44	43,3	07,6	94	92,6	16,3	144	141,8	25,0	194	191,0	33,6	244	240,3	42,3	294	289,5	51,0
45	44,3	07,8	95	93,6	16,5	145	142,8	25,1	195	192,0	33,8	245	241,3	42,5	295	290,5	51,2
46	45,3	08,0	96	94,5	16,6	146	143,8	25,3	196	193,0	34,0	246	242,3	42,7	296	291,5	51,3
47	46,3	08,1	97	95,5	16,8	147	144,8	25,5	197	194,0	34,2	247	243,2	42,8	297	292,5	51,5
48	47,3	08,3	98	96,5	17,0	148	145,7	25,7	198	195,0	34,3	248	244,2	43,0	298	293,5	51,7
49	48,3	08,5	99	97,5	17,2	149	146,7	25,8	199	196,0	34,5	249	245,2	43,2	299	294,5	51,8
50	49,2	08,7	100	98,5	17,3	150	147,7	26,0	200	197,0	34,7	250	246,2	43,4	300	295,4	52,1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 80 Deg.

11°. Difference of Latitude and Departure for 11 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,2	51	50,1	09,7	101	99,1	19,3	151	148,2	28,8	201	197,3	38,4	251	246,4	47,9
2	02,0	00,4	52	51,0	09,9	102	100,1	19,5	152	149,2	29,0	202	198,3	38,5	252	247,4	48,1
3	02,9	00,6	53	52,0	10,1	103	101,1	19,7	153	150,2	29,2	203	199,3	38,7	253	248,3	48,3
4	03,9	00,8	54	53,0	10,3	104	102,1	19,8	154	151,2	29,4	204	200,2	38,9	254	249,3	48,5
5	04,9	01,0	55	54,0	10,5	105	103,1	20,0	155	152,1	29,6	205	201,2	39,1	255	250,3	48,7
6	05,9	01,1	56	55,0	10,7	106	104,0	20,2	156	153,1	29,8	206	202,2	39,3	256	251,3	48,8
7	06,9	01,3	57	56,0	10,9	107	105,0	20,4	157	154,1	30,0	207	203,2	39,5	257	252,3	49,0
8	07,9	01,5	58	56,9	11,1	108	106,0	20,6	158	155,1	30,1	208	204,2	39,7	258	253,2	49,2
9	08,8	01,7	59	57,9	11,3	109	107,0	20,8	159	156,1	30,3	209	205,2	39,9	259	254,2	49,4
10	09,8	01,9	60	58,9	11,4	110	108,0	21,0	160	157,1	30,5	210	206,1	40,1	260	255,2	49,6
11	10,8	02,1	61	59,9	11,6	111	109,0	21,2	161	158,0	30,7	211	207,1	40,3	261	256,2	49,8
12	11,8	02,3	62	60,9	11,8	112	109,9	21,4	162	159,0	30,9	212	208,1	40,4	262	257,2	50,0
13	12,8	02,5	63	61,8	12,0	113	110,9	21,6	163	160,0	31,1	213	209,1	40,6	263	258,2	50,2
14	13,7	02,7	64	62,8	12,2	114	111,9	21,8	164	161,0	31,3	214	210,1	40,8	264	259,1	50,4
15	14,7	02,9	65	63,8	12,4	115	112,9	21,9	165	162,0	31,5	215	211,0	41,0	265	260,1	50,6
16	15,7	03,1	66	64,8	12,6	116	113,9	22,1	166	162,9	31,7	216	212,0	41,2	266	261,1	50,8
17	16,7	03,2	67	65,8	12,8	117	114,8	22,3	167	163,9	31,9	217	213,0	41,4	267	262,1	50,9
18	17,7	03,4	68	66,7	13,0	118	115,8	22,5	168	164,9	32,1	218	214,0	41,6	268	263,1	51,1
19	18,7	03,6	69	67,7	13,2	119	116,8	22,7	169	165,9	32,2	219	215,0	41,8	269	264,0	51,3
20	19,6	03,8	70	68,7	13,4	120	117,8	22,9	170	166,9	32,4	220	215,9	42,0	270	265,0	51,5
21	20,6	04,0	71	69,7	13,5	121	118,8	23,1	171	167,9	32,6	221	216,9	42,2	271	266,0	51,7
22	21,6	04,2	72	70,7	13,7	122	119,8	23,3	172	168,8	32,8	222	217,9	42,4	272	267,0	51,9
23	22,6	04,4	73	71,7	13,9	123	120,7	23,5	173	169,8	33,0	223	218,9	42,5	273	268,0	52,1
24	23,6	04,6	74	72,6	14,1	124	121,7	23,7	174	170,8	33,2	224	219,9	42,7	274	269,0	52,3
25	24,5	04,8	75	73,6	14,3	125	122,7	23,9	175	171,8	33,4	225	220,9	42,9	275	269,9	52,5
26	25,5	05,0	76	74,6	14,5	126	123,7	24,0	176	172,8	33,6	226	221,9	43,1	276	270,9	52,7
27	26,5	05,2	77	75,6	14,7	127	124,7	24,2	177	173,7	33,8	227	222,8	43,3	277	271,9	52,9
28	27,5	05,3	78	76,6	14,9	128	125,6	24,4	178	174,7	34,0	228	223,8	43,5	278	272,9	53,0
29	28,5	05,5	79	77,5	15,1	129	126,6	24,6	179	175,7	34,2	229	224,8	43,7	279	273,9	53,2
30	29,4	05,7	80	78,5	15,3	130	127,6	24,8	180	176,7	34,3	230	225,8	43,9	280	274,8	53,4
31	30,4	05,9	81	79,5	15,5	131	128,6	25,0	181	177,7	34,5	231	226,7	44,1	281	275,8	53,6
32	31,4	06,1	82	80,5	15,6	132	129,6	25,2	182	178,6	34,7	232	227,7	44,3	282	276,8	53,8
33	32,4	06,3	83	81,5	15,8	133	130,6	25,4	183	179,6	34,9	233	228,7	44,5	283	277,8	54,0
34	33,4	06,5	84	82,5	16,0	134	131,5	25,6	184	180,6	35,1	234	229,7	44,6	284	278,8	54,2
35	34,4	06,7	85	83,4	16,2	135	132,5	25,8	185	181,6	35,3	235	230,7	44,8	285	279,8	54,4
36	35,3	06,9	86	84,4	16,4	136	133,5	25,9	186	182,6	35,5	236	231,7	45,0	286	280,7	54,6
37	36,3	07,1	87	85,4	16,6	137	134,5	26,1	187	183,6	35,7	237	232,6	45,2	287	281,7	54,8
38	37,3	07,3	88	86,4	16,8	138	135,5	26,3	188	184,5	35,9	238	233,6	45,4	288	282,7	55,0
39	38,3	07,4	89	87,4	17,0	139	136,4	26,5	189	185,5	36,1	239	234,6	45,6	289	283,7	55,1
40	39,3	07,6	90	88,3	17,2	140	137,4	26,7	190	186,5	36,3	240	235,6	45,8	290	284,7	55,3
41	40,2	07,8	91	89,3	17,4	141	138,4	26,9	191	187,5	36,4	241	236,6	46,0	291	285,6	55,5
42	41,2	08,0	92	90,3	17,6	142	139,4	27,1	192	188,5	36,6	242	237,5	46,2	292	286,6	55,7
43	42,2	08,2	93	91,3	17,7	143	140,4	27,3	193	189,4	36,8	243	238,5	46,4	293	287,6	55,9
44	43,2	08,4	94	92,3	17,9	144	141,3	27,5	194	190,4	37,0	244	239,5	46,6	294	288,6	56,0
45	44,2	08,6	95	93,3	18,1	145	142,3	27,7	195	191,4	37,2	245	240,5	46,7	295	289,6	56,3
46	45,2	08,8	96	94,2	18,3	146	143,3	27,9	196	192,4	37,4	246	241,5	47,0	296	290,5	56,5
47	46,1	09,0	97	95,2	18,5	147	144,3	28,0	197	193,4	37,6	247	242,5	47,1	297	291,5	56,7
48	47,1	09,2	98	96,2	18,7	148	145,3	28,2	198	194,4	37,8	248	243,4	47,3	298	292,5	56,9
49	48,1	09,3	99	97,2	18,9	149	146,3	28,4	199	195,4	38,0	249	244,4	47,5	299	293,5	57,0
50	49,1	09,5	100	98,2	19,1	150	147,2	28,6	200	196,3	38,2	250	245,4	47,7	300	294,5	57,2
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 79 Deg.

12°. Difference of Latitude and Departure for 12 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,2	51	49,9	10,6	101	98,8	21,0	151	147,7	31,4	201	196,6	41,8	251	245,5	52,2
2	02,0	00,4	52	50,9	10,8	102	99,8	21,2	152	148,7	31,6	202	197,6	42,0	252	246,5	52,4
3	02,9	00,6	53	51,8	11,0	103	100,7	21,4	153	149,6	31,8	203	198,5	42,2	253	247,4	52,6
4	03,9	00,8	54	52,8	11,2	104	101,7	21,6	154	150,6	32,0	204	199,5	42,4	254	248,4	52,8
5	04,9	01,0	55	53,8	11,4	105	102,7	21,8	155	151,6	32,2	205	200,5	42,6	255	249,4	53,0
6	05,9	01,2	56	54,8	11,6	106	103,7	22,0	156	152,6	32,4	206	201,5	42,8	256	250,4	53,2
7	06,8	01,5	57	55,7	11,9	107	104,6	22,3	157	153,5	32,7	207	202,4	43,1	257	251,3	53,5
8	07,8	01,7	58	56,7	12,1	108	105,6	22,5	158	154,5	32,9	208	203,4	43,3	258	252,3	53,7
9	08,8	01,9	59	57,7	12,3	109	106,6	22,7	159	155,5	33,1	209	204,4	43,5	259	253,3	53,9
10	09,8	02,1	60	58,7	12,5	110	107,6	22,9	160	156,5	33,3	210	205,4	43,7	260	254,3	54,1
11	10,8	02,3	61	59,7	12,7	111	108,6	23,1	161	157,5	33,5	211	206,4	43,9	261	255,3	54,3
12	11,7	02,5	62	60,6	12,9	112	109,5	23,3	162	158,4	33,7	212	207,3	44,1	262	256,2	54,5
13	12,7	02,7	63	61,6	13,1	113	110,5	23,5	163	159,4	33,9	213	208,3	44,3	263	257,2	54,7
14	13,7	02,9	64	62,6	13,3	114	111,5	23,7	164	160,4	34,1	214	209,3	44,5	264	258,2	54,9
15	14,7	03,1	65	63,6	13,5	115	112,5	23,9	165	161,4	34,3	215	210,3	44,7	265	259,2	55,1
16	15,6	03,3	66	64,5	13,7	116	113,4	24,1	166	162,3	34,5	216	211,2	44,9	266	260,1	55,3
17	16,6	03,5	67	65,5	13,9	117	114,4	24,3	167	163,3	34,7	217	212,2	45,1	267	261,1	55,5
18	17,6	03,7	68	66,5	14,1	118	115,4	24,5	168	164,3	34,9	218	213,2	45,3	268	262,1	55,7
19	18,6	04,0	69	67,5	14,4	119	116,4	24,8	169	165,3	35,2	219	214,2	45,6	269	263,1	56,0
20	19,6	04,2	70	68,5	14,6	120	117,4	25,0	170	166,3	35,4	220	215,2	45,8	270	264,1	56,2
21	20,5	04,4	71	69,4	14,8	121	118,3	25,2	171	167,2	35,6	221	216,1	46,0	271	265,0	56,4
22	21,5	04,6	72	70,4	15,0	122	119,3	25,4	172	168,2	35,8	222	217,1	46,2	272	266,0	56,6
23	22,5	04,8	73	71,4	15,2	123	120,3	25,6	173	169,2	36,0	223	218,1	46,4	273	267,0	56,8
24	23,5	05,0	74	72,4	15,4	124	121,3	25,8	174	170,2	36,2	224	219,1	46,6	274	268,0	57,0
25	24,5	05,2	75	73,4	15,6	125	122,3	26,0	175	171,2	36,4	225	220,1	46,8	275	269,0	57,2
26	25,4	05,4	76	74,3	15,8	126	123,2	26,2	176	172,1	36,6	226	221,0	47,0	276	269,9	57,4
27	26,4	05,6	77	75,3	16,0	127	124,2	26,4	177	173,1	36,8	227	222,0	47,2	277	270,9	57,6
28	27,4	05,8	78	76,3	16,2	128	125,2	26,6	178	174,1	37,0	228	223,0	47,4	278	271,9	57,8
29	28,4	06,0	79	77,3	16,4	129	126,2	26,8	179	175,1	37,2	229	224,0	47,6	279	272,9	58,0
30	29,3	06,2	80	78,2	16,6	130	127,1	27,0	180	176,0	37,4	230	224,9	47,8	280	273,8	58,2
31	30,3	06,4	81	79,2	16,8	131	128,1	27,2	181	177,0	37,6	231	225,9	48,0	281	274,8	58,4
32	31,3	06,7	82	80,2	17,1	132	129,1	27,5	182	178,0	37,9	232	226,9	48,3	282	275,8	58,7
33	32,3	06,9	83	81,2	17,3	133	130,1	27,7	183	179,0	38,1	233	227,9	48,5	283	276,8	58,9
34	33,3	07,1	84	82,2	17,5	134	131,1	27,9	184	180,0	38,3	234	228,9	48,7	284	277,8	59,1
35	34,2	07,3	85	83,1	17,7	135	132,0	28,1	185	180,9	38,5	235	229,8	48,9	285	278,7	59,3
36	35,2	07,5	86	84,1	17,9	136	133,0	28,3	186	181,9	38,7	236	230,8	49,1	286	279,7	59,5
37	36,2	07,7	87	85,1	18,0	137	134,0	28,5	187	182,9	38,9	237	231,8	49,3	287	280,7	59,7
38	37,2	07,9	88	86,1	18,3	138	135,0	28,7	188	183,9	39,1	238	232,8	49,5	288	281,7	59,9
39	38,1	08,1	89	87,0	18,5	139	135,9	28,9	189	184,8	39,3	239	233,7	49,7	289	282,6	60,1
40	39,1	08,3	90	88,0	18,7	140	136,9	29,1	190	185,8	39,5	240	234,7	49,9	290	283,6	60,3
41	40,1	08,5	91	89,0	18,9	141	137,9	29,3	191	186,8	39,7	241	235,7	50,1	291	284,6	60,5
42	41,1	08,7	92	90,0	19,1	142	138,9	29,5	192	187,8	39,9	242	236,7	50,3	292	285,6	60,7
43	42,1	08,9	93	91,0	19,3	143	139,9	29,7	193	188,8	40,1	243	237,7	50,5	293	286,6	60,9
44	43,0	09,2	94	91,9	19,6	144	140,8	30,0	194	189,7	40,4	244	238,6	50,8	294	287,5	61,2
45	44,0	09,4	95	92,9	19,8	145	141,8	30,2	195	190,7	40,6	245	239,6	51,0	295	288,5	61,4
46	45,0	09,6	96	93,9	20,0	146	142,8	30,4	196	191,7	40,8	246	240,6	51,2	296	289,5	61,6
47	46,0	09,8	97	94,9	20,2	147	143,8	30,6	197	192,7	41,0	247	241,6	51,4	297	290,5	61,8
48	46,9	10,0	98	95,8	20,4	148	144,7	30,8	198	193,6	41,2	248	242,5	51,6	298	291,4	62,0
49	47,9	10,2	99	96,8	20,6	149	145,7	31,0	199	194,6	41,4	249	243,5	51,8	299	292,4	62,2
50	48,9	10,4	100	97,8	20,8	150	146,7	31,2	200	195,6	41,6	250	244,5	52,0	300	293,4	62,4
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 78 Deg.

13°. Difference of Latitude and Departure for 13 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,2	51	49,7	11,5	101	98,4	22,7	151	147,1	34,0	201	195,7	45,2	251	244,6	56,5
2	01,9	00,4	52	50,7	11,7	102	99,4	22,9	152	148,1	34,2	202	196,8	45,4	252	245,5	56,7
3	02,9	00,7	53	51,6	11,9	103	100,4	23,2	153	149,1	34,4	203	197,8	45,7	253	246,5	56,9
4	03,9	00,9	54	52,6	12,1	104	101,3	23,4	154	150,1	34,6	204	198,8	45,9	254	247,5	57,1
5	04,9	01,1	55	53,6	12,4	105	102,3	23,6	155	151,0	34,9	205	199,7	46,1	255	248,5	57,4
6	05,8	01,3	56	54,6	12,6	106	103,3	23,8	156	152,0	35,1	206	200,7	46,3	256	249,4	57,6
7	06,8	01,6	57	55,5	12,8	107	104,3	24,1	157	153,0	35,3	207	201,7	46,6	257	250,4	57,8
8	07,8	01,8	58	56,5	13,0	108	105,2	24,3	158	154,0	35,5	208	202,7	46,8	258	251,4	58,0
9	08,8	02,0	59	57,5	13,3	109	106,2	24,5	159	154,9	35,8	209	203,6	47,0	259	252,4	58,3
10	09,7	02,2	60	58,5	13,5	110	107,2	24,7	160	155,9	36,0	210	204,6	47,2	260	253,3	58,5
11	10,7	02,5	61	59,4	13,7	111	108,2	25,0	161	156,9	36,2	211	205,6	47,5	261	254,3	58,7
12	11,7	02,7	62	60,4	13,9	112	109,1	25,2	162	157,9	36,4	212	206,6	47,7	262	255,3	58,9
13	12,7	02,9	63	61,4	14,2	113	110,1	25,4	163	158,8	36,7	213	207,5	47,9	263	256,3	59,2
14	13,6	03,1	64	62,4	14,4	114	111,1	25,6	164	159,8	36,9	214	208,5	48,1	264	257,2	59,4
15	14,6	03,4	65	63,3	14,6	115	112,1	25,9	165	160,8	37,1	215	209,5	48,4	265	258,2	59,6
16	15,6	03,6	66	64,3	14,8	116	113,0	26,1	166	161,7	37,3	216	210,5	48,6	266	259,2	59,8
17	16,6	03,8	67	65,3	15,1	117	114,0	26,3	167	162,7	37,6	217	211,4	48,8	267	260,2	60,1
18	17,5	04,0	68	66,3	15,3	118	115,0	26,5	168	163,7	37,8	218	212,4	49,0	268	261,1	60,3
19	18,5	04,3	69	67,2	15,5	119	116,0	26,8	169	164,7	38,0	219	213,4	49,3	269	262,1	60,5
20	19,5	04,5	70	68,2	15,7	120	116,9	27,0	170	165,6	38,2	220	214,4	49,5	270	263,1	60,7
21	20,5	04,7	71	69,2	16,0	121	117,9	27,2	171	166,6	38,5	221	215,3	49,7	271	264,1	61,0
22	21,4	04,9	72	70,2	16,2	122	118,9	27,4	172	167,6	38,7	222	216,3	49,9	272	265,0	61,2
23	22,4	05,2	73	71,1	16,4	123	119,9	27,7	173	168,6	38,9	223	217,3	50,2	273	266,0	61,4
24	23,4	05,4	74	72,1	16,6	124	120,8	27,9	174	169,5	39,1	224	218,3	50,4	274	267,0	61,6
25	24,4	05,6	75	73,1	16,9	125	121,8	28,1	175	170,5	39,4	225	219,2	50,6	275	268,0	61,9
26	25,3	05,8	76	74,1	17,1	126	122,8	28,3	176	171,5	39,6	226	220,2	50,8	276	268,9	62,1
27	26,3	06,1	77	75,0	17,3	127	123,7	28,6	177	172,5	39,8	227	221,2	51,1	277	269,9	62,3
28	27,3	06,3	78	76,0	17,5	128	124,7	28,8	178	173,4	40,0	228	222,2	51,3	278	270,9	62,5
29	28,3	06,5	79	77,0	17,8	129	125,7	29,0	179	174,4	40,3	229	223,1	51,5	279	271,9	62,8
30	29,2	06,7	80	78,0	18,0	130	126,7	29,2	180	175,4	40,5	230	224,1	51,7	280	272,8	63,0
31	30,2	07,0	81	78,9	18,2	131	127,6	29,5	181	176,4	40,7	231	225,1	52,0	281	273,8	63,2
32	31,2	07,2	82	79,9	18,4	132	128,6	29,7	182	177,3	40,9	232	226,1	52,2	282	274,8	63,4
33	32,2	07,4	83	80,9	18,7	133	129,6	29,9	183	178,3	41,2	233	227,0	52,4	283	275,8	63,7
34	33,1	07,6	84	81,8	18,9	134	130,6	30,1	184	179,3	41,4	234	228,0	52,6	284	276,7	63,9
35	34,1	07,9	85	82,8	19,1	135	131,5	30,4	185	180,3	41,6	235	229,0	52,9	285	277,7	64,1
36	35,1	08,1	86	83,8	19,3	136	132,5	30,6	186	181,2	41,8	236	230,0	53,1	286	278,7	64,3
37	36,1	08,3	87	84,8	19,6	137	133,5	30,8	187	182,2	42,1	237	230,9	53,3	287	279,6	64,6
38	37,0	08,5	88	85,7	19,8	138	134,5	31,0	188	183,2	42,3	238	231,9	53,5	288	280,6	64,8
39	38,0	08,8	89	86,7	20,0	139	135,4	31,3	189	184,2	42,5	239	232,9	53,8	289	281,6	65,0
40	39,0	09,0	90	87,7	20,2	140	136,4	31,5	190	185,1	42,7	240	233,9	54,0	290	282,6	65,2
41	39,9	09,2	91	88,7	20,5	141	137,4	31,7	191	186,1	43,0	241	234,8	54,2	291	283,5	65,5
42	40,9	09,4	92	89,6	20,7	142	138,4	31,9	192	187,1	43,2	242	235,8	54,4	292	284,5	65,7
43	41,9	09,7	93	90,6	20,9	143	139,3	32,2	193	188,1	43,4	243	236,8	54,7	293	285,5	65,9
44	42,9	09,9	94	91,6	21,1	144	140,3	32,4	194	189,0	43,6	244	237,8	54,9	294	286,5	66,1
45	43,8	10,1	95	92,6	21,4	145	141,3	32,6	195	190,0	43,9	245	238,7	55,1	295	287,4	66,4
46	44,8	10,3	96	93,5	21,6	146	142,3	32,8	196	191,0	44,1	246	239,7	55,3	296	288,4	66,6
47	45,8	10,6	97	94,5	21,8	147	143,2	33,1	197	192,0	44,3	247	240,7	55,6	297	289,4	66,8
48	46,8	10,8	98	95,5	22,0	148	144,2	33,3	198	192,9	44,5	248	241,6	55,8	298	290,4	67,0
49	47,7	11,0	99	96,5	22,3	149	145,2	33,5	199	193,9	44,8	249	242,6	56,0	299	291,3	67,3
50	48,7	11,2	100	97,4	22,5	150	146,2	33,7	200	194,9	45,0	250	243,6	56,2	300	292,3	67,5
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 77 Deg.

14°. Difference of Latitude and Departure for 14 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,2	51	49,5	12,3	101	98,0	24,4	151	146,5	36,5	201	195,0	48,6	251	243,5	60,7
2	01,9	00,5	52	50,5	12,6	102	99,0	24,7	152	147,5	36,8	202	196,0	48,9	252	244,5	61,0
3	02,9	00,7	53	51,4	12,8	103	99,9	24,9	153	148,5	37,0	203	197,0	49,1	253	245,5	61,2
4	03,9	01,0	54	52,4	13,1	104	100,9	25,2	154	149,4	37,3	204	197,9	49,4	254	246,4	61,5
5	04,9	01,2	55	53,4	13,3	105	101,9	25,4	155	150,4	37,5	205	198,9	49,6	255	247,4	61,7
6	05,8	01,5	56	54,3	13,6	106	102,8	25,7	156	151,4	37,7	206	199,9	49,9	256	248,4	62,0
7	06,8	01,7	57	55,3	13,8	107	103,8	25,9	157	152,3	38,0	207	200,8	50,1	257	249,4	62,2
8	07,8	01,9	58	56,3	14,0	108	104,8	26,1	158	153,3	38,2	208	201,8	50,3	258	250,3	62,4
9	08,7	02,2	59	57,2	14,3	109	105,8	26,4	159	154,3	38,5	209	202,8	50,6	259	251,3	62,7
10	09,7	02,4	60	58,2	14,5	110	106,7	26,6	160	155,2	38,7	210	203,8	50,8	260	252,3	62,9
11	10,7	02,7	61	59,2	14,8	111	107,7	26,9	161	156,2	39,0	211	204,7	51,1	261	253,2	63,2
12	11,6	02,9	62	60,2	15,0	112	108,7	27,1	162	157,2	39,2	212	205,7	51,3	262	254,2	63,4
13	12,6	03,1	63	61,1	15,2	113	109,6	27,3	163	158,2	39,4	213	206,7	51,5	263	255,2	63,6
14	13,6	03,4	64	62,1	15,5	114	110,6	27,6	164	159,1	39,7	214	207,6	51,8	264	256,2	63,9
15	14,6	03,6	65	63,1	15,7	115	111,6	27,8	165	160,1	39,9	215	208,6	52,0	265	257,1	64,1
16	15,5	03,9	66	64,0	16,0	116	112,6	28,1	166	161,1	40,2	216	209,6	52,3	266	258,1	64,4
17	16,5	04,1	67	65,0	16,2	117	113,5	28,3	167	162,0	40,4	217	210,5	52,5	267	259,1	64,6
18	17,5	04,4	68	66,0	16,5	118	114,5	28,6	168	163,0	40,7	218	211,5	52,8	268	260,0	64,9
19	18,4	04,6	69	66,9	16,7	119	115,5	28,8	169	164,0	40,9	219	212,5	53,0	269	261,0	65,1
20	19,4	04,8	70	67,9	16,9	120	116,4	29,0	170	164,9	41,1	220	213,5	53,2	270	262,0	65,3
21	20,4	05,1	71	68,9	17,2	121	117,4	29,3	171	165,9	41,4	221	214,4	53,5	271	262,9	65,6
22	21,3	05,3	72	69,9	17,4	122	118,4	29,5	172	166,9	41,6	222	215,4	53,7	272	263,9	65,8
23	22,3	05,6	73	70,8	17,7	123	119,3	29,8	173	167,9	41,9	223	216,4	54,0	273	264,9	66,1
24	23,3	05,8	74	71,8	17,9	124	120,3	30,0	174	168,8	42,1	224	217,3	54,2	274	265,9	66,3
25	24,3	06,0	75	72,8	18,1	125	121,3	30,2	175	169,8	42,3	225	218,3	54,4	275	266,8	66,5
26	25,2	06,3	76	73,7	18,4	126	122,3	30,5	176	170,8	42,6	226	219,3	54,7	276	267,8	66,8
27	26,2	06,5	77	74,7	18,6	127	123,2	30,7	177	171,7	42,8	227	220,3	54,9	277	268,8	67,0
28	27,2	06,8	78	75,7	18,8	128	124,2	31,0	178	172,7	43,1	228	221,2	55,2	278	269,7	67,3
29	28,1	07,0	79	76,7	19,1	129	125,2	31,2	179	173,7	43,3	229	222,2	55,4	279	270,7	67,5
30	29,1	07,3	80	77,6	19,4	130	126,1	31,5	180	174,6	43,6	230	223,2	55,7	280	271,7	67,8
31	30,1	07,5	81	78,6	19,6	131	127,1	31,7	181	175,6	43,8	231	224,1	55,9	281	272,6	68,0
32	31,0	07,7	82	79,6	19,8	132	128,1	31,9	182	176,6	44,0	232	225,1	56,1	282	273,6	68,2
33	32,0	08,0	83	80,5	20,1	133	129,0	32,2	183	177,6	44,3	233	226,1	56,4	283	274,6	68,5
34	33,0	08,2	84	81,5	20,3	134	130,0	32,4	184	178,5	44,5	234	227,0	56,6	284	275,6	68,7
35	34,0	08,5	85	82,5	20,6	135	131,0	32,7	185	179,5	44,8	235	228,0	56,9	285	276,5	69,0
36	34,9	08,7	86	83,4	20,8	136	132,0	32,9	186	180,5	45,0	236	229,0	57,1	286	277,5	69,2
37	35,9	09,0	87	84,4	21,1	137	132,9	33,2	187	181,4	45,3	237	230,0	57,4	287	278,5	69,5
38	36,9	09,2	88	85,4	21,3	138	133,9	33,4	188	182,4	45,5	238	230,9	57,6	288	279,4	69,7
39	37,8	09,4	89	86,4	21,5	139	134,9	33,6	189	183,4	45,7	239	231,9	57,8	289	280,4	69,9
40	38,8	09,7	90	87,3	21,8	140	135,8	33,9	190	184,4	46,0	240	232,9	58,1	290	281,4	70,2
41	39,8	09,9	91	88,3	22,0	141	136,8	34,1	191	185,3	46,2	241	233,8	58,3	291	282,3	70,4
42	40,8	10,2	92	89,3	22,3	142	137,8	34,4	192	186,3	46,5	242	234,8	58,6	292	283,3	70,7
43	41,7	10,4	93	90,2	22,5	143	138,7	34,6	193	187,3	46,7	243	235,8	58,8	293	284,3	70,9
44	42,7	10,6	94	91,2	22,7	144	139,7	34,8	194	188,2	46,9	244	236,7	59,0	294	285,3	71,1
45	43,7	10,9	95	92,2	23,0	145	140,7	35,1	195	189,2	47,2	245	237,7	59,3	295	286,2	71,4
46	44,6	11,1	96	93,1	23,2	146	141,7	35,3	196	190,2	47,4	246	238,7	59,5	296	287,2	71,6
47	45,6	11,4	97	94,1	23,5	147	142,6	35,6	197	191,1	47,7	247	239,7	59,8	297	288,2	71,9
48	46,6	11,6	98	95,1	23,7	148	143,6	35,8	198	192,1	47,9	248	240,6	60,0	298	289,1	72,1
49	47,5	11,9	99	96,1	24,0	149	144,6	36,1	199	193,1	48,2	249	241,6	60,3	299	290,1	72,4
50	48,5	12,1	100	97,0	24,2	150	145,5	36,3	200	194,1	48,4	250	242,6	60,5	300	291,1	72,6
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 76 Deg.

15°. Difference of Latitude and Departure for 15 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01,0	00,3	51	49,3	13,2	101	97,6	26,1	151	145,8	39,1	201	194,1	52,0	251	242,4	65,0
2	01,9	00,5	52	50,2	13,5	102	98,5	26,4	152	146,8	39,3	202	195,1	52,3	252	243,4	65,2
3	02,9	00,8	53	51,2	13,7	103	99,5	26,7	153	147,8	39,6	203	196,1	52,5	253	244,4	65,5
4	03,9	01,0	54	52,2	14,0	104	100,5	26,9	154	148,7	39,9	204	197,0	52,8	254	245,3	65,7
5	04,8	01,3	55	53,1	14,2	105	101,4	27,2	155	149,7	40,1	205	198,0	53,1	255	246,3	66,0
6	05,8	01,6	56	54,1	14,5	106	102,4	27,4	156	150,7	40,4	206	199,0	53,3	256	247,3	66,3
7	06,8	01,8	57	55,1	14,8	107	103,4	27,7	157	151,6	40,6	207	199,9	53,6	257	248,2	66,5
8	07,7	02,1	58	56,0	15,0	108	104,3	28,0	158	152,6	40,9	208	200,9	53,8	258	249,2	66,8
9	08,7	02,3	59	57,0	15,3	109	105,3	28,2	159	153,6	41,1	209	201,9	54,1	259	250,2	67,0
10	09,7	02,6	60	58,0	15,5	110	106,2	28,5	160	154,5	41,4	210	202,8	54,3	260	251,1	67,3
11	10,6	02,8	61	58,9	15,8	111	107,2	28,7	161	155,5	41,7	211	203,8	54,6	261	252,1	67,5
12	11,6	03,1	62	59,9	16,0	112	108,2	29,0	162	156,5	41,9	212	204,8	54,9	262	253,1	67,8
13	12,6	03,4	63	60,9	16,3	113	109,1	29,2	163	157,4	42,2	213	205,7	55,1	263	254,0	68,1
14	13,5	03,6	64	61,8	16,6	114	110,1	29,5	164	158,4	42,4	214	206,7	55,4	264	255,0	68,3
15	14,5	03,9	65	62,8	16,8	115	111,1	29,8	165	159,4	42,7	215	207,7	55,6	265	256,0	68,6
16	15,5	04,1	66	63,7	17,1	116	112,0	30,0	166	160,3	43,0	216	208,6	55,9	266	256,9	68,8
17	16,4	04,4	67	64,7	17,3	117	113,0	30,3	167	161,3	43,2	217	209,6	56,1	267	257,9	69,1
18	17,4	04,7	68	65,7	17,6	118	114,0	30,5	168	162,3	43,5	218	210,6	56,4	268	258,9	69,4
19	18,4	04,9	69	66,6	17,9	119	114,9	30,8	169	163,2	43,7	219	211,5	56,7	269	259,8	69,6
20	19,3	05,2	70	67,6	18,1	120	115,9	31,1	170	164,2	44,0	220	212,5	56,9	270	260,8	69,9
21	20,3	05,4	71	68,6	18,4	121	116,9	31,3	171	165,2	44,3	221	213,5	57,2	271	261,8	70,1
22	21,2	05,7	72	69,5	18,6	122	117,8	31,6	172	166,1	44,5	222	214,4	57,5	272	262,7	70,4
23	22,2	06,0	73	70,5	18,9	123	118,8	31,8	173	167,1	44,8	223	215,4	57,7	273	263,7	70,7
24	23,2	06,2	74	71,5	19,2	124	119,8	32,1	174	168,1	45,0	224	216,4	58,0	274	264,7	70,9
25	24,1	06,5	75	72,4	19,4	125	120,7	32,4	175	169,0	45,3	225	217,3	58,2	275	265,6	71,2
26	25,1	06,7	76	73,4	19,7	126	121,7	32,6	176	170,0	45,5	226	218,3	58,5	276	266,6	71,4
27	26,1	07,0	77	74,4	19,9	127	122,7	32,9	177	171,0	45,8	227	219,3	58,7	277	267,6	71,7
28	27,0	07,2	78	75,3	20,2	128	123,6	33,1	178	171,9	46,1	228	220,2	59,0	278	268,5	71,9
29	28,0	07,5	79	76,3	20,4	129	124,6	33,4	179	172,9	46,3	229	221,2	59,3	279	279,5	72,2
30	29,0	07,8	80	77,3	20,7	130	125,6	33,6	180	173,9	46,6	230	222,2	59,5	280	270,5	72,5
31	29,9	08,0	81	78,2	21,0	131	126,5	33,9	181	174,8	46,8	231	223,1	59,8	281	271,4	72,7
32	30,9	08,3	82	79,2	21,2	132	127,5	34,2	182	175,8	47,1	232	224,1	60,0	282	272,4	73,0
33	31,9	08,5	83	80,2	21,5	133	128,5	34,4	183	176,8	47,4	233	225,1	60,3	283	273,4	73,2
34	32,8	08,8	84	81,1	21,7	134	129,4	34,7	184	177,7	47,6	234	226,0	60,6	284	274,3	73,5
35	33,8	09,1	85	82,1	22,0	135	130,4	34,9	185	178,7	47,9	235	227,0	60,8	285	275,3	73,8
36	34,8	09,3	86	83,1	22,3	136	131,4	35,2	186	179,7	48,1	236	228,0	61,1	286	276,2	74,0
37	35,7	09,6	87	84,0	22,5	137	132,3	35,5	187	180,6	48,4	237	228,9	61,3	287	277,2	74,3
38	36,7	09,8	88	85,0	22,8	138	133,3	35,7	188	181,6	48,7	238	229,9	61,6	288	278,2	74,5
39	37,7	10,1	89	86,0	23,0	139	134,3	36,0	189	182,6	48,9	239	230,9	61,9	289	279,1	74,8
40	38,6	10,4	90	86,9	23,3	140	135,2	36,2	190	183,5	49,2	240	231,8	62,1	290	280,1	75,0
41	39,6	10,6	91	87,9	23,6	141	136,2	36,5	191	184,5	49,4	241	232,8	62,4	291	281,1	75,3
42	40,6	10,9	92	88,9	23,8	142	137,2	36,7	192	185,5	49,7	242	233,7	62,6	292	282,0	75,6
43	41,5	11,1	93	89,8	24,1	143	138,1	37,0	193	186,4	49,9	243	234,7	62,9	293	283,0	75,8
44	42,5	11,4	94	90,8	24,3	144	139,1	37,3	194	187,4	50,2	244	235,7	63,1	294	284,0	76,1
45	43,5	11,6	95	91,8	24,6	145	140,1	37,5	195	188,4	50,5	245	236,6	63,4	295	284,9	76,3
46	44,4	11,9	96	92,7	24,8	146	141,0	37,8	196	189,3	50,7	246	237,6	63,7	296	285,9	76,6
47	45,4	12,2	97	93,7	25,1	147	142,0	38,0	197	190,3	51,0	247	238,6	63,9	297	286,9	76,9
48	46,4	12,4	98	94,7	25,4	148	143,0	38,3	198	191,2	51,2	248	239,5	64,2	298	287,8	77,1
49	47,3	12,7	99	95,6	25,6	149	143,9	38,6	199	192,2	51,5	249	240,5	64,4	299	288,8	77,4
50	48,3	12,9	100	96,6	25,9	150	144,9	38,8	200	193,2	51,8	250	241,5	64,7	300	289,8	77,6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 75 Deg.

16°. Difference of Latitude and Departure for 16 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,3	51	49,0	14,1	101	97,1	27,8	151	145,1	41,6	201	193,2	55,4	251	241,2	69,2
2	01,9	00,6	52	50,0	14,3	102	98,0	28,1	152	146,1	41,9	202	194,1	55,7	252	242,2	69,5
3	02,9	00,8	53	50,9	14,6	103	99,0	28,4	153	147,1	42,2	203	195,1	55,9	253	243,2	69,7
4	03,8	01,1	54	51,9	14,9	104	100,0	28,7	154	148,0	42,4	204	196,1	56,2	254	244,1	70,0
5	04,8	01,4	55	52,9	15,2	105	100,9	28,9	155	149,0	42,7	205	197,0	56,5	255	245,1	70,3
6	05,8	01,7	56	53,8	15,4	106	101,9	29,2	156	149,9	43,0	206	198,0	56,8	256	246,0	70,6
7	06,7	01,9	57	54,8	15,7	107	102,8	29,5	157	150,9	43,3	207	199,0	57,0	257	247,0	70,8
8	07,7	02,2	58	55,7	16,0	108	103,8	29,8	158	151,9	43,5	208	199,9	57,3	258	248,0	71,1
9	08,7	02,5	59	56,7	16,3	109	104,8	30,0	159	152,8	43,8	209	200,9	57,6	259	248,9	71,4
10	09,6	02,8	60	57,7	16,5	110	105,7	30,3	160	153,8	44,1	210	201,8	57,9	260	249,9	71,7
11	10,6	03,0	61	58,6	16,8	111	106,7	30,6	161	154,7	44,4	211	202,8	58,2	261	250,9	71,9
12	11,5	03,3	62	59,6	17,1	112	107,6	30,9	162	155,7	44,6	212	203,8	58,4	262	251,8	72,2
13	12,5	03,6	63	60,6	17,4	113	108,6	31,1	163	156,7	44,9	213	204,7	58,7	263	252,8	72,5
14	13,5	03,9	64	61,5	17,6	114	109,6	31,4	164	157,6	45,2	214	205,7	59,0	264	253,7	72,8
15	14,4	04,1	65	62,5	17,9	115	110,5	31,7	165	158,6	45,5	215	206,6	59,3	265	254,7	73,0
16	15,4	04,4	66	63,4	18,2	116	111,5	32,0	166	159,5	45,7	216	207,6	59,5	266	255,7	73,3
17	16,3	04,7	67	64,4	18,5	117	112,5	32,2	167	160,5	46,0	217	208,6	59,8	267	256,6	73,6
18	17,3	05,0	68	65,4	18,7	118	113,4	32,5	168	161,5	46,3	218	209,5	60,1	268	257,6	73,9
19	18,3	05,2	69	66,3	19,0	119	114,4	32,8	169	162,4	46,6	219	210,5	60,4	269	258,5	74,1
20	19,2	05,5	70	67,3	19,3	120	115,3	33,1	170	163,4	46,9	220	211,4	60,6	270	259,5	74,4
21	20,2	05,8	71	68,2	19,6	121	116,3	33,3	171	164,4	47,1	221	212,4	60,9	271	260,5	74,7
22	21,1	06,1	72	69,2	19,8	122	117,3	33,6	172	165,3	47,4	222	213,4	61,2	272	261,4	75,0
23	22,1	06,3	73	70,2	20,1	123	118,2	33,9	173	166,3	47,7	223	214,3	61,5	273	262,4	75,2
24	23,1	06,6	74	71,1	20,4	124	119,2	34,2	174	167,2	48,0	224	215,3	61,7	274	263,3	75,5
25	24,0	06,9	75	72,1	20,7	125	120,1	34,4	175	168,2	48,2	225	216,3	62,0	275	264,3	75,8
26	25,0	07,2	76	73,0	20,9	126	121,1	34,7	176	169,2	48,5	226	217,2	62,3	276	265,3	76,1
27	26,0	07,4	77	74,0	21,2	127	122,1	35,0	177	170,1	48,8	227	218,2	62,6	277	266,2	76,3
28	26,9	07,7	78	75,0	21,5	128	123,0	35,3	178	171,1	49,1	228	219,1	62,8	278	267,2	76,6
29	27,9	08,0	79	75,9	21,8	129	124,0	35,6	179	172,0	49,3	229	220,1	63,1	279	268,2	76,9
30	28,8	08,3	80	76,9	22,0	130	124,9	35,8	180	173,0	49,6	230	221,1	63,4	280	269,2	77,2
31	29,8	08,5	81	77,9	22,3	131	125,9	36,1	181	174,0	49,9	231	222,0	63,7	281	270,1	77,4
32	30,8	08,8	82	78,8	22,6	132	126,9	36,4	182	174,9	50,2	232	223,0	63,9	282	271,0	77,7
33	31,7	09,1	83	79,8	22,9	133	127,8	36,7	183	175,9	50,4	233	223,9	64,2	283	272,0	78,0
34	32,7	09,4	84	80,7	23,1	134	128,8	36,9	184	176,8	50,7	234	224,9	64,5	284	273,0	78,3
35	33,6	09,6	85	81,7	23,4	135	129,8	37,2	185	177,8	51,0	235	225,9	64,8	285	273,9	78,5
36	34,6	09,9	86	82,7	23,7	136	130,7	37,5	186	178,8	51,3	236	226,8	65,0	286	274,9	78,8
37	35,6	10,2	87	83,6	24,0	137	131,7	37,8	187	179,7	51,5	237	227,8	65,3	287	275,8	79,1
38	36,5	10,5	88	84,6	24,3	138	132,6	38,0	188	180,7	51,8	238	228,7	65,6	288	276,8	79,4
39	37,5	10,7	89	85,5	24,5	139	133,6	38,3	189	181,7	52,1	239	229,7	65,9	289	277,8	79,6
40	38,4	11,0	90	86,5	24,8	140	134,6	38,6	190	182,6	52,4	240	230,7	66,1	290	278,7	79,9
41	39,4	11,3	91	87,5	25,1	141	135,5	38,9	191	183,6	52,6	241	231,6	66,4	291	279,7	80,2
42	40,4	11,6	92	88,4	25,4	142	136,5	39,1	192	184,5	52,9	242	232,6	66,7	292	280,6	80,5
43	41,3	11,9	93	89,4	25,6	143	137,4	39,4	193	185,5	53,2	243	233,6	67,0	293	281,6	80,8
44	42,3	12,1	94	90,3	25,9	144	138,4	39,7	194	186,5	53,5	244	234,5	67,2	294	282,6	81,0
45	43,3	12,4	95	91,3	26,2	145	139,4	40,0	195	187,4	53,7	245	235,5	67,5	295	283,5	81,3
46	44,2	12,7	96	92,3	26,5	146	140,3	40,2	196	188,4	54,0	246	236,4	67,8	296	284,5	81,6
47	45,2	13,0	97	93,2	26,7	147	141,3	40,5	197	189,3	54,3	247	237,4	68,1	297	285,5	81,9
48	46,1	13,2	98	94,2	27,0	148	142,2	40,8	198	190,3	54,6	248	238,4	68,3	298	286,4	82,1
49	47,1	13,5	99	95,2	27,3	149	143,2	41,1	199	191,3	54,8	249	239,3	68,6	299	287,4	82,4
50	48,1	13,8	100	96,1	27,6	150	144,2	41,3	200	192,2	55,0	250	240,3	68,9	300	288,4	82,7
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 74 Deg.

17°. Difference of Latitude and Departure for 17 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	01,0	00,3	51	48,8	14,9	101	96,6	29,5	151	144,4	44,1	201	192,2	58,8	251	240,0	73,3
2	01,9	00,6	52	49,7	15,2	102	97,5	29,8	152	145,3	44,4	202	193,2	59,0	252	241,0	73,6
3	02,9	00,9	53	50,7	15,5	103	98,5	30,1	153	146,3	44,7	203	194,1	59,3	253	241,9	73,9
4	03,8	01,2	54	51,6	15,8	104	99,4	30,4	154	147,3	45,0	204	195,1	59,6	254	242,9	74,1
5	04,8	01,5	55	52,6	16,1	105	100,4	30,7	155	148,2	45,3	205	196,0	59,9	255	243,8	74,4
6	05,7	01,8	56	53,5	16,4	106	101,4	31,0	156	149,2	45,6	206	197,0	60,2	256	244,8	74,7
7	06,7	02,0	57	54,5	16,7	107	102,3	31,3	157	150,1	45,9	207	197,9	60,5	257	245,8	75,0
8	07,6	02,3	58	55,5	17,0	108	103,3	31,6	158	151,1	46,2	208	198,9	60,8	258	246,7	75,3
9	08,6	02,6	59	56,4	17,2	109	104,2	31,9	159	152,0	46,5	209	199,9	61,1	259	247,7	75,6
10	09,6	02,9	60	57,4	17,5	110	105,2	32,2	160	153,0	46,8	210	200,8	61,4	260	248,6	75,9
11	10,5	03,2	61	58,3	17,8	111	106,1	32,4	161	154,0	47,1	211	201,8	61,7	261	249,6	76,2
12	11,5	03,5	62	59,3	18,1	112	107,1	32,7	162	154,9	47,4	212	202,7	62,0	262	250,5	76,5
13	12,4	03,8	63	60,2	18,4	113	108,1	33,0	163	155,9	47,6	213	203,7	62,3	263	251,5	76,8
14	13,4	04,1	64	61,2	18,7	114	109,0	33,3	164	156,8	47,9	214	204,6	62,6	264	252,4	77,1
15	14,3	04,4	65	62,2	19,0	115	110,0	33,6	165	157,8	48,2	215	205,6	62,8	265	253,4	77,4
16	15,3	04,7	66	63,1	19,3	116	110,9	33,9	166	158,7	48,5	216	206,5	63,1	266	254,4	77,7
17	16,3	05,0	67	64,1	19,6	117	111,9	34,2	167	159,7	48,8	217	207,5	63,4	267	255,3	77,9
18	17,2	05,3	68	65,0	19,9	118	112,8	34,5	168	160,6	49,1	218	208,5	63,7	268	256,3	78,2
19	18,2	05,6	69	66,0	20,2	119	113,8	34,8	169	161,6	49,4	219	209,4	64,0	269	257,2	78,5
20	19,1	05,8	70	66,9	20,5	120	114,7	35,1	170	162,6	49,7	220	210,4	64,3	270	258,2	78,8
21	20,1	06,1	71	67,9	20,8	121	115,7	35,4	171	163,5	50,0	221	211,3	64,6	271	259,1	79,1
22	21,0	06,4	72	68,8	21,0	122	116,7	35,7	172	164,5	50,3	222	212,3	64,9	272	260,1	79,4
23	22,0	06,7	73	69,8	21,3	123	117,6	36,0	173	165,4	50,6	223	213,2	65,2	273	261,1	79,7
24	22,9	07,0	74	70,8	21,6	124	118,6	36,2	174	166,4	50,9	224	214,2	65,5	274	262,0	80,0
25	23,9	07,3	75	71,7	21,9	125	119,5	36,5	175	167,3	51,2	225	215,2	65,8	275	263,0	80,3
26	24,9	07,6	76	72,7	22,2	126	120,5	36,8	176	168,3	51,4	226	216,1	66,1	276	263,9	80,6
27	25,8	07,9	77	73,6	22,5	127	121,4	37,1	177	169,3	51,7	227	217,1	66,4	277	264,9	80,9
28	26,8	08,2	78	74,6	22,8	128	122,4	37,4	178	170,2	52,0	228	218,0	66,6	278	265,8	81,2
29	27,7	08,5	79	75,5	23,1	129	123,4	37,7	179	171,2	52,3	229	219,0	66,9	279	266,8	81,5
30	28,7	08,8	80	76,5	23,4	130	124,3	38,0	180	172,1	52,6	230	219,9	67,2	280	267,7	81,7
31	29,6	09,1	81	77,5	23,7	131	125,3	38,3	181	173,1	52,9	231	220,9	67,5	281	268,7	82,0
32	30,6	09,4	82	78,4	24,0	132	126,2	38,6	182	174,0	53,2	232	221,8	67,8	282	269,7	82,3
33	31,6	09,6	83	79,4	24,3	133	127,2	38,9	183	175,0	53,5	233	222,8	68,1	283	270,6	82,6
34	32,5	09,9	84	80,3	24,6	134	128,1	39,2	184	175,9	53,8	234	223,8	68,4	284	271,6	82,9
35	33,5	10,2	85	81,3	24,8	135	129,1	39,5	185	176,9	54,1	235	224,7	68,7	285	272,5	83,2
36	34,4	10,5	86	82,2	25,1	136	130,0	39,8	186	177,9	54,4	236	225,7	69,0	286	273,5	83,5
37	35,4	10,8	87	83,2	25,4	137	131,0	40,0	187	178,8	54,7	237	226,6	69,3	287	274,4	83,8
38	36,3	11,1	88	84,1	25,7	138	132,0	40,3	188	179,8	55,0	238	227,6	69,6	288	275,4	84,1
39	37,3	11,4	89	85,1	26,0	139	132,9	40,6	189	180,7	55,2	239	228,5	69,9	289	276,4	84,4
40	38,2	11,7	90	86,1	26,3	140	133,9	40,9	190	181,7	55,5	240	229,5	70,2	290	277,3	84,7
41	39,2	12,0	91	87,0	26,6	141	134,8	41,2	191	182,6	55,8	241	230,5	70,4	291	278,3	85,0
42	40,2	12,3	92	88,0	26,9	142	135,8	41,5	192	183,6	56,1	242	231,4	70,7	292	279,2	85,3
43	41,1	12,6	93	88,9	27,2	143	136,7	41,8	193	184,6	56,4	243	232,4	71,0	293	280,2	85,5
44	42,1	12,9	94	89,9	27,5	144	137,7	42,1	194	185,5	56,7	244	233,3	71,3	294	281,1	85,8
45	43,0	13,2	95	90,8	27,8	145	138,7	42,4	195	186,5	57,0	245	234,3	71,6	295	282,1	86,1
46	44,0	13,4	96	91,8	28,1	146	139,6	42,7	196	187,4	57,3	246	235,2	71,9	296	283,0	86,4
47	44,9	13,7	97	92,8	28,4	147	140,6	43,0	197	188,4	57,6	247	236,2	72,1	297	284,0	86,7
48	45,9	14,0	98	93,7	28,6	148	141,5	43,3	198	189,3	57,9	248	237,1	72,4	298	285,0	87,0
49	46,9	14,3	99	94,7	28,9	149	142,5	43,6	199	190,3	58,2	249	238,1	72,7	299	285,9	87,3
50	47,8	14,6	100	95,6	29,2	150	143,4	43,8	200	191,3	58,5	250	239,1	73,0	300	286,9	87,7
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 73 Deg.

18. Difference of Latitude and Departure for 18 Deg.

Diff	Lat.	Dep.	Diff	Lat.	Dep.	Diff	Lat.	Dep.	Diff	Lat.	Dep.	Diff	Lat.	Dep.	Diff	Lat.	Dep.
1	01,0	00,3	51	48,5	15,8	101	96,1	31,2	151	143,6	46,7	201	191,2	62,1	251	238,7	77,6
2	01,9	00,6	52	49,5	16,1	102	97,0	31,5	152	144,6	47,0	202	192,1	62,4	252	239,7	77,9
3	02,9	00,9	53	50,4	16,4	103	98,0	31,8	153	145,5	47,3	203	193,1	62,7	253	240,6	78,2
4	03,8	01,2	54	51,4	16,7	104	98,9	32,1	154	146,5	47,6	204	194,0	63,0	254	241,6	78,5
5	04,8	01,5	55	52,3	17,0	105	99,9	32,4	155	147,4	47,9	205	195,0	63,3	255	242,5	78,8
6	05,7	01,9	56	53,3	17,3	106	100,8	32,8	156	148,4	48,2	206	195,9	63,7	256	243,5	79,1
7	06,7	02,2	57	54,2	17,6	107	101,8	33,1	157	149,3	48,5	207	196,9	64,0	257	244,4	79,4
8	07,6	02,5	58	55,2	17,9	108	102,7	33,4	158	150,3	48,8	208	197,8	64,3	258	245,4	79,7
9	08,6	02,8	59	56,1	18,2	109	103,7	33,7	159	151,2	49,1	209	198,8	64,6	259	246,3	80,0
10	09,5	03,1	60	57,1	18,5	110	104,6	34,0	160	152,2	49,4	210	199,7	64,9	260	247,3	80,3
11	10,5	03,4	61	58,0	18,8	111	105,6	34,3	161	153,1	49,7	211	200,7	65,2	261	248,2	80,6
12	11,4	03,7	62	59,0	19,2	112	106,5	34,6	162	154,1	50,1	212	201,6	65,5	262	249,2	81,0
13	12,4	04,0	63	59,9	19,5	113	107,5	34,9	163	155,0	50,4	213	202,6	65,8	263	250,1	81,3
14	13,3	04,3	64	60,9	19,8	114	108,4	35,2	164	156,0	50,7	214	203,5	66,1	264	251,1	81,6
15	14,3	04,6	65	61,8	20,1	115	109,4	35,5	165	156,9	51,0	215	204,5	66,4	265	252,0	81,9
16	15,2	04,9	66	62,8	20,4	116	110,3	35,8	166	157,9	51,3	216	205,4	66,7	266	253,0	82,2
17	16,2	05,3	67	63,7	20,7	117	111,3	36,2	167	158,8	51,6	217	206,4	67,1	267	253,9	82,5
18	17,1	05,6	68	64,7	21,0	118	112,2	36,5	168	159,8	51,9	218	207,3	67,4	268	254,9	82,8
19	18,1	05,9	69	65,6	21,3	119	113,2	36,8	169	160,7	52,2	219	208,3	67,7	269	255,8	83,1
20	19,0	06,2	70	66,6	21,6	120	114,1	37,1	170	161,7	52,5	220	209,2	68,0	270	256,8	83,4
21	20,0	06,5	71	67,5	21,9	121	115,1	37,4	171	162,6	52,8	221	210,2	68,3	271	257,7	83,7
22	20,9	06,8	72	68,5	22,2	122	116,0	37,7	172	163,6	53,1	222	211,1	68,6	272	258,7	84,0
23	21,9	07,1	73	69,4	22,6	123	117,0	38,0	173	164,5	53,5	223	212,1	68,9	273	259,6	84,4
24	22,8	07,4	74	70,4	22,9	124	117,9	38,3	174	165,5	53,8	224	213,0	69,2	274	260,6	84,7
25	23,8	07,7	75	71,3	23,2	125	118,9	38,6	175	166,4	54,1	225	214,0	69,5	275	261,5	85,0
26	24,7	08,0	76	72,3	23,5	126	119,8	38,9	176	167,4	54,4	226	214,9	69,8	276	262,5	85,3
27	25,7	08,3	77	73,2	23,8	127	120,8	39,2	177	168,3	54,7	227	215,9	70,1	277	263,4	85,6
28	26,6	08,7	78	74,2	24,1	128	121,7	39,6	178	169,3	55,0	228	216,8	70,5	278	264,4	85,9
29	27,6	09,0	79	75,1	24,4	129	122,7	39,9	179	170,2	55,3	229	217,8	70,8	279	265,3	86,2
30	28,5	09,3	80	76,1	24,7	130	123,6	40,2	180	171,2	55,6	230	218,7	71,1	280	266,3	86,5
31	29,5	09,6	81	77,0	25,0	131	124,6	40,5	181	172,1	55,9	231	219,7	71,4	281	267,2	86,8
32	30,4	09,9	82	78,0	25,3	132	125,5	40,8	182	173,1	56,2	232	220,6	71,7	282	268,2	87,1
33	31,4	10,2	83	78,9	25,6	133	126,5	41,1	183	174,0	56,5	233	221,6	72,0	283	269,1	87,4
34	32,3	10,5	84	79,9	26,0	134	127,4	41,4	184	175,0	56,9	234	222,5	72,3	284	270,1	87,8
35	33,3	10,8	85	80,8	26,3	135	128,4	41,7	185	175,9	57,2	235	223,5	72,6	285	271,0	87,1
36	34,2	11,1	86	81,8	26,6	136	129,3	42,0	186	176,9	57,5	236	224,4	72,9	286	272,0	88,4
37	35,2	11,4	87	82,7	26,9	137	130,3	42,3	187	177,8	57,8	237	225,4	73,2	287	272,9	88,7
38	36,1	11,7	88	83,7	27,2	138	131,2	42,6	188	178,8	58,1	238	226,3	73,5	288	273,9	89,0
39	37,1	12,1	89	84,6	27,5	139	132,2	43,0	189	179,7	58,4	239	227,3	73,9	289	274,8	89,3
40	38,0	12,4	90	85,6	27,8	140	133,1	43,3	190	180,7	58,7	240	228,2	74,2	290	275,8	89,6
41	39,0	12,7	91	86,5	28,1	141	134,1	43,6	191	181,6	59,0	241	229,2	74,5	291	276,7	89,9
42	39,9	13,0	92	87,5	28,4	142	135,0	43,9	192	182,6	59,3	242	230,1	74,8	292	277,7	90,2
43	40,9	13,3	93	88,4	28,7	143	136,0	44,2	193	183,5	59,6	243	231,1	75,1	293	278,6	90,5
44	41,8	13,6	94	89,4	29,0	144	136,9	44,5	194	184,5	59,9	244	232,0	75,4	294	279,6	90,8
45	42,8	13,9	95	90,3	29,4	145	137,9	44,8	195	185,4	60,3	245	233,0	75,7	295	280,5	91,2
46	43,7	14,2	96	91,3	29,7	146	138,8	45,1	196	186,4	60,6	246	233,9	76,0	296	281,5	91,5
47	44,7	14,5	97	92,2	30,0	147	139,8	45,4	197	187,3	60,9	247	234,9	76,3	297	282,4	91,8
48	45,6	14,8	98	93,2	30,3	148	140,7	45,7	198	188,3	61,2	248	235,8	76,6	298	283,4	92,1
49	46,6	15,1	99	94,1	30,6	149	141,7	46,0	199	189,2	61,5	249	236,8	76,9	299	284,3	92,4
50	47,6	15,5	100	95,1	30,9	150	142,7	46,4	200	190,2	61,8	250	237,8	77,3	300	285,3	92,7
Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.	Diff	Dep.	Lat.

Difference of Lat. and Dep. for 72 Deg.

19°. Difference of Latitude and Departure for 19 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,9	00,3	51	48,2	16,6	101	95,5	32,9	151	142,8	49,2	201	190,0	65,4	251	237,3	81,7
2	01,9	00,7	52	49,2	16,9	102	96,4	33,2	152	143,7	49,5	202	191,0	65,8	252	238,3	82,1
3	02,8	01,0	53	50,1	17,3	103	97,4	33,5	153	144,7	49,8	203	191,9	66,1	253	239,2	82,4
4	03,8	01,3	54	51,1	17,6	104	98,3	33,9	154	145,6	50,1	204	192,9	66,4	254	240,1	82,7
5	04,7	01,6	55	52,0	17,9	105	99,3	34,2	155	146,5	50,5	205	193,8	66,7	255	241,1	83,0
6	05,7	02,0	56	52,9	18,2	106	100,2	34,5	156	147,5	50,8	206	194,8	67,1	256	242,0	83,4
7	06,6	02,3	57	53,9	18,6	107	101,2	34,8	157	148,4	51,1	207	195,7	67,4	257	243,0	83,7
8	07,6	02,6	58	54,8	18,9	108	102,1	35,2	158	149,4	51,4	208	196,7	67,7	258	243,9	84,0
9	08,5	02,9	59	55,8	19,2	109	103,1	35,5	159	150,3	51,8	209	197,6	68,1	259	244,9	84,3
10	09,5	03,3	60	56,7	19,5	110	104,0	35,8	160	151,3	52,1	210	198,5	68,4	260	245,8	84,7
11	10,4	03,6	61	57,7	19,9	111	104,9	36,1	161	152,2	52,4	211	199,5	68,7	261	246,8	85,0
12	11,3	03,9	62	58,6	20,2	112	105,9	36,5	162	153,2	52,7	212	200,4	69,0	262	247,7	85,3
13	12,3	04,2	63	59,6	20,5	113	106,8	36,8	163	154,1	53,1	213	201,4	69,4	263	248,7	85,6
14	13,2	04,6	64	60,5	20,8	114	107,8	37,1	164	155,1	53,4	214	202,3	69,7	264	249,6	86,0
15	14,2	04,9	65	61,5	21,2	115	108,7	37,4	165	156,0	53,7	215	203,3	70,0	265	250,5	86,3
16	15,1	05,2	66	62,4	21,5	116	109,7	37,8	166	156,9	54,0	216	204,2	70,3	266	251,5	86,6
17	16,1	05,5	67	63,3	21,8	117	110,6	38,1	167	157,9	54,4	217	205,2	70,7	267	252,4	86,9
18	17,0	05,9	68	64,3	22,1	118	111,6	38,4	168	158,8	54,7	218	206,1	71,0	268	253,4	87,3
19	18,0	06,2	69	65,2	22,5	119	112,5	38,7	169	159,8	55,0	219	207,1	71,3	269	254,3	87,6
20	18,9	06,5	70	66,2	22,8	120	113,5	39,1	170	160,7	55,4	220	208,0	71,6	270	255,3	87,9
21	19,9	06,8	71	67,1	23,1	121	114,4	39,4	171	161,7	55,7	221	208,9	72,0	271	256,2	88,2
22	20,8	07,2	72	68,1	23,4	122	115,3	39,7	172	162,6	56,0	222	209,9	72,3	272	257,2	88,6
23	21,7	07,5	73	69,0	23,8	123	116,3	40,0	173	163,6	56,3	223	210,8	72,6	273	258,1	88,9
24	22,7	07,8	74	70,0	24,1	124	117,2	40,4	174	164,5	56,7	224	211,8	72,9	274	259,1	89,2
25	23,6	08,1	75	70,9	24,4	125	118,2	40,7	175	165,5	57,0	225	212,7	73,3	275	260,0	89,5
26	24,6	08,5	76	71,9	24,7	126	119,1	41,0	176	166,4	57,3	226	213,7	73,6	276	260,9	89,9
27	25,5	08,8	77	72,8	25,1	127	120,1	41,4	177	167,3	57,6	227	214,6	73,9	277	261,9	90,2
28	26,5	09,1	78	73,7	25,4	128	121,0	41,7	178	168,3	58,0	228	215,6	74,2	278	262,8	90,5
29	27,4	09,4	79	74,7	25,7	129	122,0	42,0	179	169,2	58,3	229	216,5	74,6	279	263,8	90,8
30	28,4	09,8	80	75,6	26,0	130	122,9	42,3	180	170,2	58,6	230	217,5	74,9	280	264,7	91,2
31	29,3	10,1	81	76,6	26,4	131	123,9	42,7	181	171,1	58,9	231	218,4	75,2	281	265,7	91,5
32	30,3	10,4	82	77,5	26,7	132	124,8	43,0	182	172,1	59,3	232	219,3	75,5	282	266,6	91,8
33	31,2	10,7	83	78,5	27,0	133	125,7	43,3	183	173,0	59,6	233	220,3	75,9	283	267,6	92,1
34	32,1	11,1	84	79,4	27,4	134	126,7	43,6	184	174,0	59,9	234	221,2	76,2	284	268,5	92,5
35	33,1	11,4	85	80,4	27,7	135	127,6	44,0	185	174,9	60,2	235	222,2	76,5	285	269,5	92,8
36	34,0	11,7	86	81,3	28,0	136	128,6	44,3	186	175,9	60,6	236	223,1	76,8	286	270,4	93,1
37	35,0	12,0	87	82,3	28,3	137	129,5	44,6	187	176,8	60,9	237	224,1	77,2	287	271,3	93,4
38	35,9	12,4	88	83,2	28,7	138	130,5	44,9	188	177,7	61,2	238	225,0	77,5	288	272,3	93,8
39	36,9	12,7	89	84,1	29,0	139	131,4	45,3	189	178,7	61,5	239	226,0	77,8	289	273,2	94,1
40	37,8	13,0	90	85,1	29,3	140	132,4	45,6	190	179,6	61,9	240	226,9	78,1	290	274,2	94,4
41	38,8	13,3	91	86,0	29,6	141	133,3	45,9	191	180,6	62,2	241	227,9	78,5	291	275,1	94,7
42	39,7	13,7	92	87,0	30,0	142	134,3	46,2	192	181,5	62,5	242	228,8	78,8	292	276,1	95,1
43	40,7	14,0	93	87,9	30,3	143	135,2	46,6	193	182,5	62,8	243	229,7	79,1	293	277,0	95,4
44	41,6	14,3	94	88,9	30,6	144	136,1	46,9	194	183,4	63,2	244	230,7	79,4	294	278,0	95,7
45	42,5	14,7	95	89,8	30,9	145	137,1	47,2	195	184,4	63,5	245	231,6	79,8	295	278,9	96,1
46	43,5	15,0	96	90,8	31,3	146	138,0	47,5	196	185,3	63,8	246	232,6	80,1	296	279,9	96,4
47	44,4	15,3	97	91,7	31,6	147	139,0	47,9	197	186,3	64,1	247	233,5	80,4	297	280,8	96,7
48	45,4	15,6	98	92,7	31,9	148	139,9	48,2	198	187,2	64,5	248	234,5	80,7	298	281,7	97,0
49	46,3	16,0	99	93,6	32,2	149	140,9	48,5	199	188,1	64,8	249	235,4	81,1	299	282,7	97,4
50	47,3	16,3	100	94,5	32,6	150	141,8	48,8	200	189,1	65,1	250	236,4	81,4	300	283,6	97,7
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 71 Deg.

20°. Difference of Latitude and Departure for 20 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,3	51	47,9	17,4	101	94,9	34,5	151	141,9	51,6	201	188,9	68,7	251	235,9	85,8
2	01,9	00,7	52	48,9	17,8	102	95,8	34,9	152	142,8	52,0	202	189,8	69,1	252	236,8	86,2
3	02,8	01,0	53	49,8	18,1	103	96,8	35,2	153	143,8	52,3	203	190,8	69,4	253	237,7	86,5
4	03,8	01,4	54	50,7	18,5	104	97,7	35,6	154	144,7	52,7	204	191,7	69,8	254	238,7	86,9
5	04,7	01,7	55	51,7	18,8	105	98,7	35,9	155	145,7	53,0	205	192,6	70,1	255	239,6	87,2
6	05,6	02,1	56	52,6	19,2	106	99,6	36,3	156	146,6	53,4	206	193,6	70,5	256	240,6	87,6
7	06,6	02,4	57	53,6	19,5	107	100,5	36,6	157	147,5	53,7	207	194,5	70,8	257	241,5	87,9
8	07,5	02,7	58	54,5	19,8	108	101,5	36,9	158	148,5	54,0	208	195,5	71,1	258	242,4	88,2
9	08,5	03,1	59	55,4	20,2	109	102,4	37,3	159	149,4	54,4	209	196,4	71,5	259	243,4	88,6
10	09,4	03,4	60	56,4	20,5	110	103,4	37,6	160	150,4	54,7	210	197,3	71,8	260	244,3	88,9
11	10,3	03,8	61	57,3	20,9	111	104,3	38,0	161	151,3	55,1	211	198,3	72,2	261	245,3	89,3
12	11,3	04,1	62	58,3	21,2	112	105,2	38,3	162	152,2	55,4	212	199,2	72,5	262	246,2	89,6
13	12,2	04,4	63	59,2	21,5	113	106,2	38,6	163	153,2	55,7	213	200,2	72,8	263	247,1	89,9
14	13,2	04,8	64	60,1	21,9	114	107,1	39,0	164	154,1	56,1	214	201,1	73,2	264	248,1	90,3
15	14,1	05,1	65	61,1	22,2	115	108,1	39,3	165	155,1	56,4	215	202,0	73,5	265	249,0	90,6
16	15,0	05,5	66	62,0	22,6	116	109,0	39,7	166	156,0	56,8	216	203,0	73,9	266	250,0	91,0
17	16,0	05,8	67	63,0	22,9	117	109,9	40,0	167	156,9	57,1	217	203,9	74,2	267	250,9	91,3
18	16,9	06,2	68	63,9	23,3	118	110,9	40,4	168	157,9	57,5	218	204,9	74,6	268	251,8	91,7
19	17,9	06,5	69	64,8	23,6	119	111,8	40,7	169	158,8	57,8	219	205,8	74,9	269	252,8	92,0
20	18,8	06,8	70	65,8	23,9	120	112,8	41,0	170	159,7	58,1	220	206,7	75,2	270	253,7	92,3
21	19,7	07,2	71	66,7	24,3	121	113,7	41,4	171	160,7	58,5	221	207,7	75,6	271	254,7	92,7
22	20,7	07,5	72	67,7	24,6	122	114,6	41,7	172	161,6	58,8	222	208,6	75,9	272	255,6	93,0
23	21,6	07,9	73	68,6	25,0	123	115,6	42,1	173	162,6	59,2	223	209,6	76,3	273	256,5	93,4
24	22,6	08,2	74	69,5	25,3	124	116,5	42,4	174	163,5	59,5	224	210,5	76,6	274	257,5	93,7
25	23,5	08,6	75	70,5	25,7	125	117,5	42,8	175	164,4	59,9	225	211,4	77,0	275	258,4	94,1
26	24,4	08,9	76	71,4	26,0	126	118,4	43,1	176	165,4	60,2	226	212,4	77,3	276	259,4	94,4
27	25,4	09,2	77	72,4	26,3	127	119,3	43,4	177	166,3	60,5	227	213,3	77,6	277	260,3	94,7
28	26,3	09,6	78	73,3	26,7	128	120,3	43,8	178	167,3	60,9	228	214,3	78,0	278	261,2	95,1
29	27,3	09,9	79	74,2	27,0	129	121,2	44,1	179	168,2	61,2	229	215,2	78,3	279	262,2	95,4
30	28,2	10,3	80	75,2	27,4	130	122,2	44,5	180	169,1	61,6	230	216,1	78,7	280	263,1	95,8
31	29,1	10,6	81	76,1	27,7	131	123,1	44,8	181	170,1	61,9	231	217,1	79,0	281	264,1	96,1
32	30,1	10,9	82	77,1	28,0	132	124,0	45,1	182	171,0	62,2	232	218,0	79,3	282	265,0	96,4
33	31,0	11,3	83	78,0	28,4	133	125,0	45,5	183	172,0	62,6	233	219,0	79,7	283	265,9	96,8
34	31,9	11,6	84	78,9	28,7	134	125,9	45,8	184	172,9	62,9	234	219,9	80,0	284	266,9	97,1
35	32,9	12,0	85	79,9	29,1	135	126,9	46,2	185	173,8	63,3	235	220,8	80,4	285	267,8	97,5
36	33,8	12,3	86	80,8	29,4	136	127,8	46,5	186	174,8	63,6	236	221,8	80,7	286	268,8	97,8
37	34,8	12,7	87	81,8	29,8	137	128,7	46,9	187	175,7	64,0	237	222,7	81,1	287	269,7	98,2
38	35,7	13,0	88	82,7	30,1	138	129,7	47,2	188	176,7	64,3	238	223,6	81,4	288	270,6	98,5
39	36,6	13,3	89	83,6	30,4	139	130,6	47,5	189	177,6	64,6	239	224,6	81,7	289	271,6	98,8
40	37,6	13,7	90	84,6	30,8	140	131,6	47,9	190	178,5	65,0	240	225,5	82,1	290	272,5	99,2
41	38,5	14,0	91	85,5	31,1	141	132,5	48,2	191	179,5	65,3	241	226,5	82,4	291	273,5	99,5
42	39,5	14,4	92	86,5	31,5	142	133,4	48,6	192	180,4	65,7	242	227,4	82,8	292	274,4	99,9
43	40,4	14,7	93	87,4	31,8	143	134,4	48,9	193	181,4	66,0	243	228,3	83,1	293	275,3	100,2
44	41,3	15,0	94	88,3	32,1	144	135,3	49,2	194	182,3	66,3	244	229,3	83,4	294	276,3	100,5
45	42,3	15,4	95	89,3	32,5	145	136,3	49,6	195	183,2	66,7	245	230,2	83,8	295	277,2	100,9
46	43,2	15,7	96	90,2	32,8	146	137,2	49,9	196	184,2	67,0	246	231,2	84,1	296	278,2	101,1
47	44,2	16,1	97	91,2	33,2	147	138,1	50,3	197	185,1	67,4	247	232,1	84,5	297	279,1	101,6
48	45,1	16,4	98	92,1	33,5	148	139,1	50,6	198	186,1	67,7	248	233,0	84,8	298	280,0	101,9
49	46,0	16,8	99	93,0	33,9	149	140,0	51,0	199	187,0	68,1	249	234,0	85,2	299	281,0	102,3
50	47,0	17,1	100	94,0	34,2	150	141,0	51,3	200	187,9	68,4	250	234,9	85,5	300	281,9	102,6
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 70 Deg.

21°. Difference of Latitude and Departure for 21 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,4	51	47,6	18,3	101	94,3	36,2	151	141,0	54,1	201	187,6	72,0	251	234,3	90,0
2	01,9	00,7	52	48,5	18,6	102	95,3	36,6	152	141,9	54,5	202	188,6	72,4	252	235,3	90,3
3	02,8	01,1	53	49,5	19,0	103	96,2	36,9	153	142,9	54,8	203	189,5	72,8	253	236,2	90,7
4	03,7	01,4	54	50,4	19,4	104	97,1	37,3	154	143,8	55,2	204	190,4	73,1	254	237,1	91,0
5	04,7	01,8	55	51,3	19,7	105	98,0	37,6	155	144,7	55,6	205	191,4	73,5	255	238,1	91,4
6	05,6	02,2	56	52,3	20,1	106	99,0	38,0	156	145,7	55,9	206	192,3	73,8	256	239,0	91,8
7	06,5	02,5	57	53,2	20,4	107	99,9	38,3	157	146,6	56,3	207	193,2	74,2	257	239,9	92,1
8	07,5	02,9	58	54,1	20,8	108	100,9	38,7	158	147,5	56,6	208	194,2	74,5	258	240,9	92,5
9	08,4	03,2	59	55,1	21,1	109	101,8	39,1	159	148,5	57,0	209	195,1	74,9	259	241,8	92,8
10	09,3	03,6	60	56,0	21,5	110	102,7	39,4	160	149,4	57,3	210	196,0	75,3	260	242,7	93,2
11	10,3	03,9	61	56,9	21,9	111	103,7	39,8	161	150,3	57,7	211	197,0	75,6	261	243,7	93,5
12	11,2	04,3	62	57,9	22,2	112	104,6	40,1	162	151,3	58,1	212	197,9	76,0	262	244,6	93,9
13	12,1	04,7	63	58,8	22,6	113	105,5	40,5	163	152,2	58,4	213	198,8	76,3	263	245,5	94,3
14	13,1	05,0	64	59,7	22,9	114	106,5	40,9	164	153,1	58,8	214	199,8	76,7	264	246,5	94,6
15	14,0	05,4	65	60,7	23,3	115	107,4	41,2	165	154,1	59,1	215	200,7	77,1	265	247,4	94,0
16	14,9	05,7	66	61,6	23,7	116	108,3	41,6	166	155,0	59,5	216	201,6	77,4	266	248,3	95,3
17	15,9	06,1	67	62,5	24,0	117	109,3	41,9	167	155,9	59,9	217	202,6	77,8	267	249,3	95,7
18	16,8	06,5	68	63,5	24,4	118	110,2	42,3	168	156,9	60,2	218	203,5	78,1	268	250,2	96,1
19	17,7	06,8	69	64,4	24,7	119	111,1	42,6	169	157,8	60,6	219	204,4	78,5	269	251,1	96,4
20	18,7	07,2	70	65,3	25,1	120	112,1	43,0	170	158,7	60,9	220	205,4	78,8	270	252,1	96,8
21	19,6	07,5	71	66,3	25,4	121	113,0	43,4	171	159,7	61,3	221	206,3	79,2	271	253,0	97,1
22	20,5	07,9	72	67,2	25,8	122	113,9	43,7	172	160,6	61,6	222	207,2	79,6	272	253,9	97,5
23	21,5	08,2	73	68,1	26,2	123	114,9	44,1	173	161,5	62,0	223	208,2	79,9	273	254,9	97,8
24	22,4	08,6	74	69,1	26,5	124	115,8	44,4	174	162,5	62,4	224	209,1	80,3	274	255,8	98,2
25	23,3	09,0	75	70,0	26,9	125	116,7	44,8	175	163,4	62,7	225	210,0	80,6	275	256,7	98,6
26	24,3	09,3	76	70,9	27,2	126	117,7	45,2	176	164,3	63,1	226	211,0	81,0	276	257,7	98,9
27	25,2	09,7	77	71,9	27,6	127	118,6	45,5	177	165,3	63,4	227	211,9	81,4	277	258,6	99,3
28	26,1	10,0	78	72,8	28,0	128	119,5	45,9	178	166,2	63,8	228	212,8	81,7	278	259,5	99,6
29	27,1	10,4	79	73,7	28,3	129	120,5	46,2	179	167,1	64,2	229	213,8	82,1	279	260,5	100,0
30	28,0	10,8	80	74,7	28,7	130	121,4	46,6	180	168,1	64,5	230	214,7	82,4	280	261,4	100,4
31	28,9	11,1	81	75,6	29,0	131	122,3	47,0	181	169,0	64,9	231	215,6	82,8	281	262,3	100,7
32	29,9	11,5	82	76,5	29,4	132	123,3	47,3	182	169,9	65,2	232	216,6	83,1	282	263,3	101,1
33	30,8	11,8	83	77,5	29,7	133	124,2	47,7	183	170,9	65,6	233	217,5	83,5	283	264,2	101,4
34	31,7	12,2	84	78,4	30,1	134	125,1	48,0	184	171,8	65,9	234	218,5	83,9	284	265,1	101,8
35	32,7	12,5	85	79,3	30,5	135	126,1	48,4	185	172,7	66,3	235	219,4	84,2	285	266,1	102,1
36	33,6	12,9	86	80,3	30,8	136	127,0	48,7	186	173,7	66,7	236	220,3	84,6	286	267,0	102,5
37	34,5	13,3	87	81,2	31,2	137	127,9	49,1	187	174,6	67,0	237	221,2	84,9	287	267,9	102,9
38	35,5	13,6	88	82,1	31,5	138	128,9	49,5	188	175,5	67,4	238	222,2	85,3	288	268,9	103,2
39	36,4	14,0	89	83,1	31,9	139	129,8	49,8	189	176,5	67,7	239	223,1	85,7	289	269,8	103,6
40	37,3	14,3	90	84,0	32,3	140	130,7	50,2	190	177,4	68,1	240	224,1	86,0	290	270,7	103,9
41	38,3	14,7	91	84,9	32,6	141	131,7	50,5	191	178,3	68,5	241	225,0	86,4	291	271,7	104,3
42	39,2	15,1	92	85,9	33,0	142	132,6	50,9	192	179,3	68,8	242	225,9	86,7	292	272,6	104,7
43	40,1	15,4	93	86,8	33,3	143	133,5	51,3	193	180,2	69,2	243	226,9	87,1	293	273,5	105,0
44	41,1	15,8	94	87,7	33,7	144	134,5	51,6	194	181,1	69,5	244	227,8	87,4	294	274,5	105,4
45	42,0	16,1	95	88,7	34,0	145	135,4	52,0	195	182,1	69,9	245	228,7	87,8	295	275,4	105,7
46	42,9	16,5	96	89,6	34,4	146	136,3	52,3	196	183,0	70,2	246	229,7	88,2	296	276,3	106,1
47	43,9	16,8	97	90,5	34,8	147	137,3	52,7	197	183,9	70,6	247	230,6	88,5	297	277,3	106,4
48	44,8	17,2	98	91,5	35,1	148	138,2	53,0	198	184,9	71,0	248	231,5	89,9	298	278,2	106,8
49	45,7	17,6	99	92,4	35,5	149	139,1	53,4	199	185,8	71,4	249	232,5	89,2	299	279,1	107,2
50	46,7	17,9	100	93,4	35,8	150	140,1	53,8	200	186,7	71,8	250	233,4	89,6	300	280,1	107,5
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 69 Deg.

22°. Difference of Latitude and Departure for 22 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,4	51	47,3	19,1	101	93,6	37,8	151	140,0	56,6	201	186,4	75,3	251	232,7	94,0
2	01,9	00,7	52	48,2	19,5	102	94,6	38,2	152	140,9	56,9	202	187,3	75,7	252	233,7	94,4
3	02,8	01,1	53	49,1	19,9	103	95,5	38,6	153	141,9	57,3	203	188,2	76,0	253	234,6	94,8
4	03,7	01,5	54	50,1	20,2	104	96,4	39,0	154	142,8	57,7	204	189,1	76,4	254	235,5	95,2
5	04,6	01,9	55	51,0	20,6	105	97,4	39,3	155	143,7	58,1	205	190,1	76,8	255	236,4	95,5
6	05,6	02,2	56	51,9	21,0	106	98,3	39,7	156	144,6	58,4	206	191,0	77,2	256	237,4	95,9
7	06,5	02,6	57	52,9	21,4	107	99,2	40,1	157	145,6	58,8	207	191,9	77,5	257	238,3	96,3
8	07,4	03,0	58	53,8	21,7	108	100,1	40,5	158	146,5	59,2	208	192,9	77,9	258	239,2	96,6
9	08,3	03,4	59	54,7	22,1	109	101,1	40,8	159	147,4	59,6	209	193,8	78,3	259	240,1	97,0
10	09,3	03,7	60	55,6	22,5	110	102,0	41,2	160	148,4	59,9	210	194,7	78,7	260	241,1	97,4
11	10,2	04,1	61	56,6	22,9	111	102,9	41,6	161	149,3	60,3	211	195,6	79,0	261	242,0	97,8
12	11,1	04,5	62	57,5	23,2	112	103,8	42,0	162	150,2	60,7	212	196,6	79,4	262	242,9	98,1
13	12,1	04,9	63	58,4	23,6	113	104,8	42,3	163	151,1	61,1	213	197,5	79,7	263	243,9	98,5
14	13,0	05,2	64	59,3	24,0	114	105,7	42,7	164	152,1	61,4	214	198,4	80,2	264	244,8	98,9
15	13,9	05,6	65	60,3	24,3	115	106,6	43,1	165	153,0	61,8	215	199,3	80,5	265	245,7	99,3
16	14,8	06,0	66	61,2	24,7	116	107,6	43,5	166	153,9	62,2	216	200,3	80,9	266	246,6	99,6
17	15,8	06,4	67	62,1	25,1	117	108,5	43,8	167	154,8	62,6	217	201,2	81,3	267	247,6	100,0
18	16,7	06,7	68	63,0	25,5	118	109,4	44,2	168	155,8	62,9	218	202,1	81,7	268	248,5	100,4
19	17,6	07,1	69	64,0	25,8	119	110,3	44,6	169	156,7	63,3	219	203,1	82,0	269	249,4	100,8
20	18,5	07,5	70	64,9	26,2	120	111,3	45,0	170	157,6	63,7	220	204,0	82,4	270	250,3	101,1
21	19,5	07,9	71	65,8	26,6	121	112,2	45,3	171	158,6	64,1	221	204,9	82,8	271	251,3	101,5
22	20,4	08,2	72	66,8	27,0	122	113,1	45,7	172	159,5	64,4	222	205,8	83,2	272	252,2	101,9
23	21,3	08,6	73	67,7	27,3	123	114,0	46,1	173	160,4	64,8	223	206,7	83,5	273	253,1	102,3
24	22,3	09,0	74	68,6	27,7	124	115,0	46,5	174	161,3	65,2	224	207,7	83,9	274	254,1	102,6
25	23,2	09,4	75	69,5	28,1	125	115,9	46,8	175	162,3	65,6	225	208,6	84,3	275	255,0	103,0
26	24,1	09,7	76	70,5	28,5	126	116,8	47,2	176	163,2	65,9	226	209,5	84,7	276	255,9	103,4
27	25,0	10,1	77	71,4	28,8	127	117,8	47,6	177	164,1	66,3	227	210,5	85,0	277	256,8	103,8
28	26,0	10,5	78	72,3	29,2	128	118,7	47,9	178	165,0	66,7	228	211,4	85,4	278	257,8	104,1
29	26,9	10,9	79	73,2	29,6	129	119,6	48,3	179	166,0	67,1	229	212,3	85,8	279	258,7	104,5
30	27,8	11,2	80	74,2	30,0	130	120,5	48,7	180	166,9	67,4	230	213,3	86,2	280	259,6	104,9
31	28,7	11,6	81	75,1	30,3	131	121,5	49,1	181	167,8	67,8	231	214,2	86,5	281	260,5	105,3
32	29,7	12,0	82	76,0	30,7	132	122,4	49,4	182	168,8	68,2	232	215,1	86,9	282	261,5	105,6
33	30,6	12,4	83	77,0	31,1	133	123,3	49,8	183	169,7	68,6	233	216,0	87,3	283	262,4	106,0
34	31,5	12,7	84	77,9	31,5	134	124,2	50,2	184	170,6	68,9	234	217,0	87,7	284	263,3	106,4
35	32,5	13,1	85	78,8	31,8	135	125,2	50,6	185	171,5	69,3	235	217,9	88,0	285	264,3	106,8
36	33,4	13,5	86	79,7	32,2	136	126,1	50,9	186	172,5	69,7	236	218,8	88,4	286	265,2	107,1
37	34,3	13,9	87	80,7	32,6	137	127,0	51,3	187	173,4	70,1	237	219,7	88,8	287	266,1	107,5
38	35,2	14,2	88	81,6	33,0	138	128,0	51,7	188	174,3	70,4	238	220,7	89,2	288	267,0	107,9
39	36,2	14,6	89	82,5	33,3	139	128,9	52,1	189	175,2	70,8	239	221,6	89,5	289	268,0	108,3
40	37,1	15,0	90	83,4	33,7	140	129,8	52,4	190	176,2	71,2	240	222,5	89,9	290	268,9	108,6
41	38,0	15,4	91	84,4	34,1	141	130,7	52,8	191	177,1	71,5	241	223,5	90,3	291	269,8	109,0
42	38,9	15,7	92	85,3	34,5	142	131,7	53,2	192	178,0	71,9	242	224,4	90,7	292	270,7	109,4
43	39,9	16,1	93	86,2	34,8	143	132,6	53,6	193	178,9	72,3	243	225,3	91,0	293	271,7	109,8
44	40,8	16,5	94	87,2	35,2	144	133,5	53,9	194	179,8	72,7	244	226,2	91,4	294	272,6	110,1
45	41,7	16,9	95	88,1	35,6	145	134,4	54,3	195	180,8	73,0	245	227,2	91,8	295	273,5	110,5
46	42,7	17,2	96	89,0	36,0	146	135,4	54,7	196	181,7	73,4	246	228,1	92,2	296	274,5	110,9
47	43,6	17,6	97	89,9	36,3	147	136,3	55,1	197	182,7	73,8	247	229,0	92,5	297	275,4	111,3
48	44,5	18,0	98	90,9	36,7	148	137,2	55,4	198	183,6	74,2	248	229,9	92,9	298	276,3	111,6
49	45,4	18,4	99	91,8	37,1	149	138,2	55,8	199	184,5	74,5	249	230,9	93,3	299	277,2	112,0
50	46,4	18,7	100	92,7	37,5	150	139,1	56,2	200	185,4	74,9	250	231,8	93,7	300	278,2	112,4
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 68 Deg.

23°. Difference of Latitude and Departure for 23 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,9	00,4	51	46,9	19,9	101	93,0	39,5	151	139,0	59,0	201	185,0	78,5	251	231,0	98,1
2	01,9	00,8	52	47,9	20,3	102	93,9	39,9	152	139,9	59,4	202	185,9	78,9	252	232,0	98,5
3	02,8	01,2	53	48,8	20,7	103	94,8	40,2	153	140,8	59,8	203	186,9	79,3	253	232,9	98,8
4	03,7	01,6	54	49,7	21,1	104	95,7	40,6	154	141,8	60,2	204	187,8	79,7	254	233,8	99,2
5	04,6	02,0	55	50,6	21,5	105	96,7	41,0	155	142,7	60,6	205	188,7	80,1	255	234,7	99,6
6	05,5	02,3	56	51,5	21,9	106	97,6	41,4	156	143,6	60,9	206	189,6	80,5	256	235,6	100,0
7	06,4	02,7	57	52,5	22,3	107	98,5	41,8	157	144,5	61,3	207	190,5	80,9	257	236,6	100,4
8	07,4	03,1	58	53,4	22,7	108	99,4	42,2	158	145,4	61,7	208	191,5	81,3	258	237,5	100,8
9	08,3	03,5	59	54,3	23,1	109	100,3	42,6	159	146,4	62,1	209	192,4	81,7	259	238,4	101,2
10	09,2	03,9	60	55,2	23,4	110	101,3	43,0	160	147,3	62,5	210	193,3	82,0	260	239,3	101,6
11	10,1	04,3	61	56,1	23,8	111	102,2	43,4	161	148,2	62,9	211	194,2	82,4	261	240,2	102,0
12	11,0	04,7	62	57,1	24,2	112	103,1	43,8	162	149,1	63,3	212	195,1	82,8	262	241,2	102,4
13	12,0	05,1	63	58,0	24,6	113	104,0	44,1	163	150,6	63,7	213	196,1	83,2	263	242,1	102,8
14	12,9	05,5	64	58,9	25,0	114	104,9	44,5	164	151,0	64,1	214	197,0	83,6	264	243,0	103,1
15	13,8	05,9	65	59,8	25,4	115	105,9	44,9	165	151,9	64,5	215	197,9	84,0	265	243,9	103,5
16	14,7	06,3	66	60,8	25,8	116	106,8	45,3	166	152,8	64,9	216	198,8	84,4	266	244,9	103,9
17	15,6	06,6	67	61,7	26,2	117	107,7	45,7	167	153,7	65,2	217	199,7	84,8	267	245,8	104,3
18	16,6	07,0	68	62,6	26,6	118	108,6	46,1	168	154,6	65,6	218	200,7	85,2	268	246,7	104,7
19	17,5	07,4	69	63,5	27,0	119	109,5	46,5	169	155,6	66,0	219	201,6	85,6	269	247,6	105,1
20	18,4	07,8	70	64,4	27,3	120	110,5	46,9	170	156,5	66,4	220	202,5	86,0	270	248,5	105,5
21	19,3	08,2	71	65,4	27,7	121	111,4	47,3	171	157,4	66,8	221	203,4	86,3	271	249,5	105,9
22	20,3	08,6	72	66,3	28,1	122	112,3	47,7	172	158,3	67,2	222	204,4	86,7	272	250,4	106,3
23	21,2	09,0	73	67,2	28,5	123	113,2	48,1	173	159,2	67,6	223	205,3	87,1	273	251,3	106,7
24	22,1	09,4	74	68,1	28,9	124	114,1	48,4	174	160,2	68,0	224	206,2	87,5	274	252,2	107,1
25	23,0	09,8	75	69,0	29,3	125	115,1	48,8	175	161,1	68,4	225	207,1	87,9	275	253,1	107,4
26	23,9	10,2	76	70,0	29,7	126	116,0	49,2	176	162,0	68,8	226	208,0	88,3	276	254,1	107,8
27	24,9	10,5	77	70,9	30,1	127	116,9	49,6	177	162,9	69,2	227	209,0	88,7	277	255,0	108,2
28	25,8	10,9	78	71,8	30,5	128	117,8	50,0	178	163,8	69,5	228	209,9	89,1	278	255,9	108,6
29	26,7	11,3	79	72,7	30,9	129	118,7	50,4	179	164,8	69,9	229	210,8	89,5	279	256,8	109,0
30	27,6	11,7	80	73,6	31,3	130	119,7	50,8	180	165,7	70,3	230	211,7	89,9	280	257,7	109,4
31	28,5	12,1	81	74,6	31,6	131	120,6	51,2	181	166,6	70,7	231	212,6	90,3	281	258,7	109,8
32	29,5	12,5	82	75,5	32,0	132	121,5	51,6	182	167,5	71,1	232	213,6	90,6	282	259,6	110,2
33	30,4	12,9	83	76,4	32,4	133	122,4	52,0	183	168,5	71,5	233	214,5	91,0	283	260,5	110,6
34	31,3	13,3	84	77,3	32,8	134	123,3	52,4	184	169,4	71,9	234	215,4	91,4	284	261,4	111,0
35	32,2	13,7	85	78,2	33,2	135	124,3	52,7	185	170,3	72,3	235	216,3	91,8	285	262,3	111,3
36	33,1	14,1	86	79,2	33,6	136	125,2	53,1	186	171,2	72,7	236	217,2	92,2	286	263,3	111,7
37	34,1	14,5	87	80,1	34,0	137	126,1	53,5	187	172,1	73,1	237	218,2	92,6	287	264,2	112,1
38	35,0	14,8	88	81,0	34,4	138	127,0	53,9	188	173,1	73,5	238	219,1	93,0	288	265,1	112,5
39	35,9	15,2	89	81,9	34,8	139	127,9	54,3	189	174,0	73,8	239	220,0	93,4	289	266,0	112,9
40	36,8	15,6	90	82,8	35,2	140	128,9	54,7	190	174,9	74,2	240	220,9	93,8	290	266,9	113,3
41	37,7	16,0	91	83,8	35,6	141	129,8	55,1	191	175,8	74,6	241	221,8	94,2	291	267,9	113,7
42	38,7	16,4	92	84,7	35,9	142	130,7	55,5	192	176,7	75,0	242	222,8	94,5	292	268,8	114,1
43	39,6	16,8	93	85,6	36,3	143	131,6	55,9	193	177,7	75,4	243	223,7	94,9	293	269,7	114,5
44	40,5	17,2	94	86,5	36,7	144	132,6	56,3	194	178,6	75,8	244	224,6	95,3	294	270,6	114,9
45	41,4	17,6	95	87,4	37,1	145	133,5	56,7	195	179,5	76,2	245	225,5	95,7	295	271,5	115,3
46	42,3	18,0	96	88,4	37,5	146	134,4	57,0	196	180,4	76,6	246	226,4	96,1	296	272,5	115,6
47	43,3	18,4	97	89,3	37,9	147	135,3	57,4	197	181,3	77,0	247	227,4	96,5	297	273,4	116,0
48	44,2	18,8	98	90,2	38,3	148	136,2	57,8	198	182,3	77,4	248	228,3	96,9	298	274,3	116,4
49	45,1	19,1	99	91,1	38,7	149	137,2	58,2	199	183,2	77,7	249	229,2	97,3	299	275,2	116,8
50	46,0	19,5	100	92,0	39,1	150	138,1	58,6	200	184,1	78,1	250	230,1	97,7	300	276,2	117,2
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 67 Deg.

24°. Difference of Latitude and Departure for 24 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,4	51	46,6	20,7	101	92,3	41,1	151	137,9	61,4	201	183,6	81,7	251	229,3	102,1
2	01,8	00,8	52	47,5	21,1	102	93,2	41,5	152	138,9	61,8	202	184,5	82,2	252	230,2	102,5
3	02,7	01,2	53	48,4	21,6	103	94,1	41,9	153	139,8	62,2	203	185,4	82,6	253	231,1	102,9
4	03,7	01,6	54	49,3	22,0	104	95,0	42,3	154	140,7	62,6	204	186,4	83,0	254	232,0	103,3
5	04,6	02,0	55	50,2	22,4	105	95,9	42,7	155	141,6	63,0	205	187,3	83,4	255	232,9	103,7
6	05,5	02,4	56	51,2	22,8	106	96,8	43,1	156	142,5	63,4	206	188,2	83,8	256	233,9	104,1
7	06,4	02,8	57	52,1	23,2	107	97,7	43,5	157	143,4	63,9	207	189,1	84,2	257	234,8	104,5
8	07,3	03,3	58	53,0	23,6	108	98,7	43,9	158	144,3	64,3	208	190,0	84,6	258	235,7	104,9
9	08,2	03,7	59	53,9	24,0	109	99,6	44,3	159	145,2	64,7	209	190,9	85,0	259	236,6	105,3
10	09,1	04,1	60	54,8	24,4	110	100,5	44,7	160	146,2	65,1	210	191,8	85,4	260	237,5	105,7
11	10,0	04,5	61	55,7	24,8	111	101,4	45,1	161	147,1	65,5	211	192,7	85,8	261	238,4	106,1
12	11,0	04,9	62	56,6	25,2	112	102,3	45,6	162	148,0	65,9	212	193,7	86,2	262	239,3	106,6
13	11,9	05,3	63	57,6	25,6	113	103,2	46,0	163	148,9	66,3	213	194,6	86,6	263	240,3	107,0
14	12,8	05,7	64	58,5	26,0	114	104,1	46,4	164	149,8	66,7	214	195,5	87,0	264	241,2	107,4
15	13,7	06,1	65	59,4	26,4	115	105,1	46,8	165	150,7	67,1	215	196,4	87,4	265	242,1	107,8
16	14,6	06,5	66	60,3	26,8	116	106,0	47,2	166	151,6	67,5	216	197,3	87,8	266	243,0	108,2
17	15,5	06,9	67	61,2	27,2	117	106,9	47,6	167	152,6	67,9	217	198,2	88,3	267	243,9	108,6
18	16,4	07,3	68	62,1	27,7	118	107,8	48,0	168	153,5	68,3	218	199,1	88,7	268	244,8	109,0
19	17,4	07,7	69	63,0	28,1	119	108,7	48,4	169	154,4	68,7	219	200,1	89,1	269	245,7	109,4
20	18,3	08,1	70	63,9	28,5	120	109,6	48,8	170	155,3	69,1	220	201,0	89,5	270	246,6	109,8
21	19,2	08,5	71	64,9	28,9	121	110,5	49,2	171	156,2	69,5	221	201,9	89,9	271	247,6	110,2
22	20,1	08,9	72	65,8	29,3	122	111,4	49,6	172	157,1	70,0	222	202,8	90,3	272	248,5	110,6
23	21,0	09,4	73	66,7	29,7	123	112,4	50,0	173	158,0	70,4	223	203,7	90,7	273	249,4	111,0
24	21,9	09,8	74	67,6	30,1	124	113,3	50,4	174	158,9	70,8	224	204,6	91,1	274	250,3	111,4
25	22,8	10,2	75	68,5	30,5	125	114,2	50,8	175	159,9	71,2	225	205,5	91,5	275	251,2	111,8
26	23,8	10,6	76	69,4	30,9	126	115,1	51,2	176	160,8	71,6	226	206,5	91,9	276	252,1	112,2
27	24,7	11,0	77	70,3	31,3	127	116,0	51,7	177	161,7	72,0	227	207,4	92,3	277	253,0	112,7
28	25,6	11,4	78	71,3	31,7	128	116,9	52,1	178	162,6	72,4	228	208,3	92,7	278	254,0	113,1
29	26,5	11,8	79	72,2	32,1	129	117,8	52,5	179	163,5	72,8	229	209,2	93,1	279	254,9	113,5
30	27,4	12,2	80	73,1	32,5	130	118,8	52,9	180	164,4	73,2	230	210,1	93,5	280	255,8	113,9
31	28,3	12,6	81	74,0	32,9	131	119,7	53,3	181	165,3	73,6	231	211,0	93,9	281	256,7	114,3
32	29,2	13,0	82	74,9	33,3	132	120,6	53,7	182	166,3	74,0	232	211,9	94,4	282	257,6	114,7
33	30,1	13,4	83	75,8	33,8	133	121,5	54,1	183	167,2	74,4	233	212,8	94,8	283	258,5	114,1
34	31,1	13,8	84	76,7	34,2	134	122,4	54,5	184	168,1	74,8	234	213,8	95,2	284	259,4	115,5
35	32,0	14,2	85	77,6	34,6	135	123,3	54,9	185	169,0	75,2	235	214,7	95,6	285	260,3	115,9
36	32,9	14,6	86	78,6	35,0	136	124,2	55,3	186	169,9	75,6	236	215,6	96,0	286	261,3	116,3
37	33,8	15,0	87	79,5	35,4	137	125,1	55,7	187	170,8	76,1	237	216,5	96,4	287	262,2	116,7
38	34,7	15,5	88	80,4	35,8	138	126,1	56,1	188	171,7	76,5	238	217,4	96,8	288	263,1	117,1
39	35,6	15,9	89	81,3	36,2	139	127,0	56,5	189	172,7	76,9	239	218,3	97,2	289	264,0	117,5
40	36,5	16,3	90	82,2	36,6	140	127,9	56,9	190	173,6	77,3	240	219,2	97,6	290	264,9	117,9
41	37,5	16,7	91	83,1	37,0	141	128,8	57,3	191	174,5	77,7	241	220,2	98,0	291	265,8	118,3
42	38,4	17,1	92	84,0	37,4	142	129,7	57,8	192	175,4	78,1	242	221,1	98,4	292	266,7	118,8
43	39,3	17,5	93	85,0	37,8	143	130,6	58,2	193	176,3	78,5	243	222,0	98,8	293	267,7	119,2
44	40,2	17,9	94	85,9	38,2	144	131,5	58,6	194	177,2	78,9	244	222,9	99,9	294	268,6	119,6
45	41,1	18,3	95	86,8	38,6	145	132,5	59,0	195	178,1	79,3	245	223,8	99,6	295	269,5	120,0
46	42,0	18,7	96	87,7	39,0	146	133,4	59,4	196	179,0	79,7	246	224,7	100,0	296	270,4	120,4
47	42,9	19,1	97	88,6	39,4	147	134,3	59,8	197	180,0	80,1	247	225,6	100,5	297	271,3	120,8
48	43,8	19,5	98	89,5	39,9	148	135,2	60,2	198	180,9	80,5	248	226,5	100,9	298	272,2	121,2
49	44,8	19,9	99	90,4	40,3	149	136,1	60,6	199	181,8	80,9	249	227,5	101,3	299	273,1	121,6
50	45,7	20,3	100	91,4	40,7	150	137,0	61,0	200	182,7	81,3	250	228,4	101,7	300	274,1	122,0
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 66 Deg.

25°. Difference of Latitude and Departure for 25 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00,9	00,4	51	46,2	21,6	101	91,5	42,7	151	136,9	63,8	201	182,2	84,9	251	227,5	106,1
2	01,8	00,8	52	47,1	22,0	102	92,4	43,1	152	137,8	64,2	202	183,1	85,4	252	228,4	106,5
3	02,7	01,3	53	48,0	22,4	103	93,3	43,5	153	138,7	64,7	203	184,0	85,8	253	229,3	106,9
4	03,6	01,7	54	48,9	22,8	104	94,3	44,0	154	139,6	65,1	204	184,9	86,2	254	230,2	107,3
5	04,5	02,1	55	49,8	23,2	105	95,2	44,4	155	140,5	65,5	205	185,8	86,6	255	231,1	107,8
6	05,4	02,5	56	50,8	23,7	106	96,1	44,8	156	141,4	65,9	206	186,7	87,1	256	232,0	108,2
7	06,3	03,0	57	51,7	24,1	107	97,0	45,2	157	142,3	66,3	207	187,6	87,5	257	232,9	108,6
8	07,3	03,4	58	52,6	24,5	108	97,9	45,6	158	143,2	66,8	208	188,5	87,9	258	233,8	109,0
9	08,2	03,8	59	53,5	24,9	109	98,8	46,1	159	144,1	67,2	209	189,4	88,3	259	334,7	109,5
10	09,1	04,2	60	54,4	25,4	110	99,7	46,5	160	145,0	67,6	210	190,3	88,7	260	235,6	109,9
11	10,0	04,6	61	55,3	25,8	111	100,6	46,9	161	145,9	68,0	211	191,2	89,2	261	236,5	110,3
12	10,9	05,0	62	56,2	26,2	112	101,5	47,3	162	146,8	68,5	212	192,1	89,6	262	237,5	110,7
13	11,8	05,5	63	57,1	26,6	113	102,4	47,8	163	147,7	68,9	213	193,0	90,0	263	238,4	111,1
14	12,7	05,9	64	58,0	27,0	114	103,3	48,2	164	148,6	69,3	214	193,9	90,4	264	239,3	111,6
15	13,6	06,3	65	58,9	27,5	115	104,2	48,6	165	149,5	69,7	215	194,9	90,9	265	240,2	112,0
16	14,5	06,8	66	59,8	27,9	116	105,1	49,0	166	150,4	70,2	216	195,8	91,3	266	241,1	112,4
17	15,4	07,2	67	60,7	28,3	117	106,0	49,4	167	151,4	70,6	217	196,7	91,7	267	242,0	112,8
18	16,3	07,6	68	61,6	28,7	118	106,9	49,9	168	152,3	71,0	218	197,6	92,1	268	242,9	113,3
19	17,2	08,0	69	62,5	29,2	119	107,8	50,3	169	153,2	71,4	219	198,5	92,5	269	243,8	113,7
20	18,1	08,5	70	63,4	29,6	120	108,8	50,7	170	154,1	71,8	220	199,4	93,0	270	244,7	114,1
21	19,0	08,9	71	64,3	30,0	121	109,7	51,1	171	155,0	72,3	221	200,3	93,4	271	245,6	114,5
22	19,9	09,3	72	65,3	30,4	122	110,6	51,6	172	155,9	72,7	222	201,2	93,8	272	246,5	114,9
23	20,8	09,7	73	66,2	30,8	123	111,5	52,0	173	156,8	73,1	223	202,1	94,2	273	247,4	115,4
24	21,8	10,1	74	67,1	31,3	124	112,4	52,4	174	157,7	73,5	224	203,0	94,7	274	248,3	115,8
25	22,7	10,6	75	68,0	31,7	125	113,3	52,8	175	158,6	74,0	225	203,9	95,1	275	249,2	116,2
26	23,6	11,0	76	68,9	32,1	126	114,2	53,2	176	159,5	74,4	226	204,8	95,5	276	250,1	116,6
27	24,5	11,4	77	69,8	32,5	127	115,1	53,7	177	160,4	74,8	227	205,7	95,9	277	251,0	117,1
28	25,4	11,8	78	70,7	33,0	128	116,0	54,1	178	161,3	75,2	228	206,6	96,4	278	252,0	117,5
29	26,3	12,3	79	71,6	33,4	129	116,9	54,5	179	162,2	75,6	229	207,5	96,8	279	252,9	117,9
30	27,2	12,7	80	72,5	33,8	130	117,8	54,9	180	163,1	76,1	230	208,4	97,2	280	253,8	118,3
31	28,1	13,1	81	73,4	34,2	131	118,7	55,4	181	164,0	76,5	231	209,4	97,6	281	254,7	118,8
32	29,0	13,5	82	74,3	34,7	132	119,6	55,8	182	164,9	76,9	232	210,3	98,0	282	255,6	119,2
33	29,9	13,9	83	75,2	35,1	133	120,5	56,2	183	165,9	77,3	233	211,2	98,5	283	256,5	119,6
34	30,8	14,4	84	76,1	35,5	134	121,4	56,6	184	166,8	77,8	234	212,1	98,9	284	257,4	120,0
35	31,7	14,8	85	77,0	35,9	135	122,4	57,1	185	167,7	78,2	235	213,0	99,3	285	258,3	120,4
36	32,6	15,2	86	77,9	36,3	136	123,3	57,5	186	168,6	78,6	236	213,9	99,7	286	259,2	120,9
37	33,5	15,6	87	78,8	36,8	137	124,2	57,9	187	169,5	79,0	237	214,8	100,2	287	260,1	121,3
38	34,4	16,1	88	79,8	37,2	138	125,1	58,3	188	170,4	79,4	238	215,7	100,6	288	261,0	121,7
39	35,3	16,5	89	80,7	37,6	139	126,0	58,7	189	171,3	79,9	239	216,6	101,0	289	261,9	122,1
40	36,3	16,9	90	81,6	38,0	140	126,9	59,2	190	172,2	80,3	240	217,5	101,4	290	262,8	122,6
41	37,2	17,3	91	82,5	38,5	141	127,8	59,6	191	173,1	80,7	241	218,4	101,8	291	263,7	123,0
42	38,1	17,7	92	83,4	38,9	142	128,7	60,0	192	174,0	81,1	242	219,3	102,3	292	264,6	123,4
43	39,0	18,2	93	84,3	39,3	143	129,6	60,4	193	174,9	81,6	243	220,2	102,7	293	265,5	123,8
44	39,9	18,6	94	85,2	39,7	144	130,5	60,9	194	175,8	82,0	244	221,1	103,1	294	266,5	124,2
45	40,8	19,0	95	86,1	40,1	145	131,4	61,3	195	176,7	82,4	245	222,0	103,5	295	267,4	124,7
46	41,7	19,4	96	87,0	40,6	146	132,3	61,7	196	177,6	82,8	246	222,9	104,0	296	268,3	125,1
47	42,6	19,9	97	87,9	41,0	147	133,2	62,1	197	178,5	83,3	247	223,9	104,4	297	269,2	125,5
48	43,5	20,3	98	88,8	41,4	148	134,1	62,5	198	179,4	83,7	248	224,8	104,8	298	270,1	125,9
49	44,4	20,7	99	89,7	41,8	149	135,0	63,0	199	180,4	84,1	249	225,7	105,2	299	271,0	126,4
50	45,3	21,1	100	90,6	42,3	150	135,9	63,4	200	181,3	84,5	250	226,6	105,7	300	271,9	126,8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 65 Deg.

26°. Difference of Latitude and Departure for 26 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00,9	00,4	51	45,8	22,4	101	90,8	44,3	151	135,7	66,2	201	180,7	88,1	251	225,6	110,0
2	01,8	00,9	52	46,7	22,8	102	91,7	44,7	152	136,6	66,6	202	181,6	88,6	252	226,5	110,5
3	02,7	01,3	53	47,6	23,2	103	92,6	45,2	153	137,5	67,1	203	182,5	89,0	253	227,4	110,9
4	03,6	01,8	54	48,5	23,7	104	93,5	45,6	154	138,4	67,5	204	183,4	89,4	254	228,3	111,4
5	04,5	02,2	55	49,4	24,1	105	94,4	46,0	155	139,3	68,0	205	184,3	89,9	255	229,2	111,8
6	05,4	02,6	56	50,3	24,6	106	95,3	46,5	156	140,2	68,4	206	185,2	90,3	256	230,1	112,2
7	06,3	03,1	57	51,2	25,0	107	96,2	46,9	157	141,1	68,8	207	186,1	90,7	257	231,0	112,7
8	07,2	03,5	58	52,1	25,4	108	97,1	47,3	158	142,0	69,3	208	187,0	91,2	258	231,9	113,1
9	08,1	03,9	59	53,0	25,9	109	98,0	47,8	159	142,9	69,7	209	187,8	91,6	259	232,8	113,5
10	09,0	04,4	60	53,9	26,3	110	98,9	48,2	160	143,8	70,1	210	188,7	92,1	260	233,7	114,0
11	09,9	04,8	61	54,8	26,7	111	99,8	48,7	161	144,7	70,6	211	189,6	92,5	261	234,6	114,4
12	10,8	05,3	62	55,7	27,2	112	100,7	49,1	162	145,6	71,0	212	190,5	92,9	262	235,5	114,9
13	11,7	05,7	63	56,6	27,6	113	101,6	49,5	163	146,5	71,5	213	191,4	93,4	263	236,4	115,3
14	12,6	06,1	64	57,5	28,1	114	102,5	50,0	164	147,4	71,9	214	192,3	93,8	264	237,3	115,7
15	13,5	06,6	65	58,4	28,5	115	103,4	50,4	165	148,3	72,3	215	193,2	94,3	265	238,2	116,2
16	14,4	07,0	66	59,3	28,9	116	104,3	50,9	166	149,2	72,8	216	194,1	94,7	266	239,1	116,6
17	15,3	07,5	67	60,2	29,4	117	105,2	51,3	167	150,1	73,2	217	195,0	95,1	267	240,0	117,1
18	16,2	07,9	68	61,1	29,8	118	106,1	51,7	168	151,0	73,7	218	195,9	95,6	268	240,9	117,5
19	17,1	08,3	69	62,0	30,2	119	107,0	52,2	169	151,9	74,1	219	196,8	96,0	269	241,8	117,9
20	18,0	08,7	70	62,9	30,7	120	107,9	52,6	170	152,8	74,5	220	197,7	96,4	270	242,7	118,4
21	18,9	09,2	71	63,8	31,1	121	108,8	53,0	171	153,7	75,0	221	198,6	96,9	271	243,6	118,8
22	19,8	09,6	72	64,7	31,6	122	109,7	53,5	172	154,6	75,4	222	199,5	97,3	272	244,5	119,2
23	20,7	10,1	73	65,6	32,0	123	110,6	53,9	173	155,5	75,8	223	200,4	97,8	273	245,4	119,7
24	21,6	10,5	74	66,5	32,4	124	111,5	54,4	174	156,4	76,3	224	201,3	98,2	274	246,3	120,1
25	22,5	11,0	75	67,4	32,9	125	112,4	54,8	175	157,3	76,7	225	202,2	98,6	275	247,2	120,6
26	23,4	11,4	76	68,3	33,3	126	113,2	55,2	176	158,2	77,2	226	203,1	99,1	276	248,1	121,0
27	24,3	11,8	77	69,2	33,8	127	114,1	55,7	177	159,1	77,6	227	204,0	99,5	277	249,0	121,4
28	25,2	12,3	78	70,1	34,2	128	115,0	56,1	178	160,0	78,0	228	204,9	100,0	278	249,9	121,9
29	26,1	12,7	79	71,0	34,6	129	115,9	56,6	179	160,9	78,5	229	205,8	100,4	279	250,8	122,3
30	27,0	13,2	80	71,9	35,1	130	116,8	57,0	180	161,8	78,9	230	206,7	100,8	280	251,7	122,8
31	27,9	13,6	81	72,8	35,5	131	117,7	57,4	181	162,7	79,4	231	207,6	101,3	281	252,6	123,2
32	28,8	14,0	82	73,7	35,9	132	118,6	57,9	182	163,6	79,8	232	208,5	101,7	282	253,5	123,6
33	29,7	14,5	83	74,6	36,4	133	119,5	58,3	183	164,5	80,2	233	209,4	102,1	283	254,4	124,1
34	30,6	14,9	84	75,5	36,8	134	120,4	58,7	184	165,4	80,7	234	210,3	102,6	284	255,3	124,5
35	31,5	15,3	85	76,4	37,3	135	121,3	59,2	185	166,3	81,1	235	211,2	103,0	285	256,2	124,9
36	32,4	15,8	86	77,3	37,7	136	122,2	59,6	186	167,2	81,5	236	212,1	103,5	286	257,1	125,4
37	33,3	16,2	87	78,2	38,1	137	123,1	60,1	187	168,1	82,0	237	213,0	103,9	287	258,0	125,8
38	34,2	16,7	88	79,1	38,6	138	124,0	60,5	188	169,0	82,4	238	213,9	104,3	288	258,9	126,3
39	35,1	17,1	89	80,0	39,0	139	124,9	60,9	189	169,9	82,9	239	214,8	104,8	289	259,8	126,7
40	36,0	17,5	90	80,9	39,5	140	125,8	61,4	190	170,8	83,3	240	215,7	105,2	290	260,7	127,1
41	36,9	18,0	91	81,8	39,9	141	126,7	61,8	191	171,7	83,7	241	216,6	105,7	291	261,6	127,6
42	37,7	18,4	92	82,7	40,3	142	127,6	62,3	192	172,6	84,2	242	217,5	106,1	292	262,4	128,0
43	38,6	18,9	93	83,6	40,8	143	128,5	62,7	193	173,5	84,6	243	218,4	106,5	293	263,3	128,5
44	39,5	19,3	94	84,5	41,2	144	129,4	63,1	194	174,4	85,0	244	219,3	107,0	294	264,2	128,9
45	40,4	19,7	95	85,4	41,6	145	130,3	63,6	195	175,3	85,5	245	220,2	107,4	295	265,1	129,3
46	41,3	20,2	96	86,3	42,1	146	131,2	64,0	196	176,2	85,9	246	221,1	107,8	296	266,0	129,8
47	42,2	20,6	97	87,2	42,5	147	132,1	64,4	197	177,1	86,4	247	222,0	108,3	297	266,9	130,2
48	43,1	21,0	98	88,1	43,0	148	133,0	64,9	198	178,0	86,8	248	222,9	108,7	298	267,8	130,6
49	44,0	21,5	99	89,0	43,4	149	133,9	65,3	199	178,9	87,2	249	223,8	109,2	299	268,7	131,1
50	44,9	21,9	100	89,9	43,8	150	134,8	65,7	200	179,8	87,7	250	224,7	109,6	300	269,6	131,5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 64 Deg.

27°. Difference of Latitude and Departure for 27 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,5	51	45,4	23,2	101	90,0	45,9	151	134,5	68,6	201	179,1	91,3	251	223,6	114,0
2	01,8	00,9	52	46,3	23,6	102	90,9	46,3	152	135,4	69,0	202	180,0	91,7	252	224,5	114,4
3	02,7	01,4	53	47,2	24,1	103	91,8	46,8	153	136,3	69,5	203	180,9	92,2	253	225,4	114,9
4	03,6	01,8	54	48,1	24,5	104	92,7	47,2	154	137,2	69,9	204	181,8	92,6	254	226,3	115,3
5	04,5	02,3	55	49,0	25,0	105	93,6	47,7	155	138,1	70,4	205	182,7	93,1	255	227,2	115,8
6	05,3	02,7	56	49,9	25,4	106	94,4	48,1	156	139,0	70,8	206	183,5	93,5	256	228,1	116,2
7	06,2	03,2	57	50,8	25,9	107	95,3	48,6	157	139,9	71,3	207	184,4	94,0	257	229,0	116,7
8	07,1	03,6	58	51,7	26,3	108	96,2	49,0	158	140,8	71,7	208	185,3	94,4	258	229,9	117,1
9	08,0	04,1	59	52,6	26,8	109	97,1	49,5	159	141,7	72,2	209	186,2	94,9	259	230,8	117,6
10	08,9	04,5	60	53,5	27,2	110	98,0	49,9	160	142,6	72,6	210	187,1	95,3	260	231,7	118,0
11	09,8	05,0	61	54,4	27,7	111	98,9	50,4	161	143,5	73,1	211	188,0	95,8	261	232,6	118,5
12	10,7	05,4	62	55,2	28,1	112	99,8	50,8	162	144,3	73,5	212	188,9	96,2	262	233,4	118,9
13	11,6	05,9	63	56,1	28,6	113	100,7	51,3	163	145,2	74,0	213	189,8	96,7	263	234,3	119,4
14	12,5	06,4	64	57,0	29,1	114	101,6	51,8	164	146,1	74,5	214	190,7	97,2	264	235,2	119,9
15	13,4	06,8	65	57,9	29,5	115	102,5	52,2	165	147,0	74,9	215	191,6	97,6	265	236,1	120,3
16	14,3	07,3	66	58,8	30,0	116	103,4	52,7	166	147,9	75,4	216	192,5	98,1	266	237,0	120,8
17	15,1	07,7	67	59,7	30,4	117	104,2	53,1	167	148,8	75,8	217	193,3	98,5	267	237,9	121,2
18	16,0	08,2	68	60,6	30,9	118	105,1	53,6	168	149,7	76,3	218	194,2	99,0	268	238,8	121,7
19	16,9	08,6	69	61,5	31,3	119	106,0	54,0	169	150,6	76,7	219	195,1	99,4	269	239,7	122,1
20	17,8	09,1	70	62,4	31,8	120	106,9	54,5	170	151,5	77,2	220	196,0	99,9	270	240,6	122,6
21	18,7	09,5	71	63,3	32,2	121	107,8	54,9	171	152,4	77,6	221	196,9	100,3	271	241,5	123,3
22	19,6	10,0	72	64,2	32,7	122	108,7	55,4	172	153,3	78,1	222	197,8	100,8	272	242,4	123,5
23	20,5	10,4	73	65,0	33,1	123	109,6	55,8	173	154,1	78,5	223	198,7	101,2	273	243,2	123,9
24	21,4	10,9	74	65,9	33,6	124	110,5	56,3	174	155,0	79,0	224	199,6	101,7	274	244,1	124,4
25	22,3	11,4	75	66,8	34,1	125	111,4	56,8	175	155,9	79,5	225	200,5	102,2	275	245,0	124,9
26	23,2	11,8	76	67,7	34,5	126	112,3	57,2	176	156,8	79,9	226	201,4	102,6	276	245,9	125,3
27	24,1	12,3	77	68,6	35,0	127	113,2	57,7	177	157,7	80,4	227	202,3	103,1	277	246,8	125,8
28	24,9	12,7	78	69,5	35,4	128	114,0	58,1	178	158,6	80,8	228	203,1	103,5	278	247,7	126,2
29	25,8	13,2	79	70,4	35,9	129	114,9	58,6	179	159,5	81,3	229	204,0	104,0	279	248,6	126,7
30	26,7	13,6	80	71,3	36,3	130	115,8	59,0	180	160,4	81,7	230	204,9	104,4	280	249,5	127,1
31	27,6	14,1	81	72,2	36,8	131	116,7	59,5	181	161,3	82,2	231	205,8	104,9	281	250,4	127,6
32	28,5	14,5	82	73,1	37,2	132	117,6	59,9	182	162,2	82,6	232	206,7	105,3	282	251,3	128,0
33	29,4	15,0	83	74,0	37,7	133	118,5	60,4	183	163,1	83,1	233	207,6	105,8	283	252,2	128,5
34	30,3	15,4	84	74,8	38,1	134	119,4	60,8	184	163,9	83,5	234	208,5	106,2	284	253,0	128,9
35	31,2	15,9	85	75,7	38,6	135	120,3	61,3	185	164,8	84,0	235	209,4	106,7	285	253,9	129,4
36	32,1	16,3	86	76,6	39,0	136	121,2	61,7	186	165,7	84,4	236	210,3	107,1	286	254,8	129,8
37	33,0	16,8	87	77,5	39,5	137	122,1	62,2	187	166,6	84,9	237	211,2	107,6	287	255,7	130,3
38	33,9	17,3	88	78,4	40,0	138	123,0	62,7	188	167,5	85,4	238	212,1	108,1	288	256,6	130,8
39	34,7	17,7	89	79,3	40,4	139	123,8	63,1	189	168,4	85,8	239	212,9	108,5	289	257,5	131,2
40	35,6	18,2	90	80,2	40,9	140	124,7	63,6	190	169,3	86,3	240	213,8	109,0	290	258,4	131,7
41	36,5	18,6	91	81,1	41,3	141	125,6	64,0	191	170,2	86,7	241	214,7	109,4	291	259,3	132,1
42	37,4	19,1	92	82,0	41,8	142	126,5	64,5	192	171,1	87,2	242	215,6	109,9	292	260,2	132,6
43	38,3	19,5	93	82,9	42,2	143	127,4	64,9	193	172,0	87,6	243	216,5	110,3	293	261,1	133,0
44	39,2	20,0	94	83,8	42,7	144	128,3	65,4	194	172,9	88,1	244	217,4	110,8	294	262,0	133,5
45	40,1	20,4	95	84,6	43,1	145	129,2	65,8	195	173,7	88,5	245	218,3	111,2	295	262,8	133,9
46	41,0	20,9	96	85,5	43,6	146	130,1	66,3	196	174,6	89,0	246	219,2	111,7	296	263,7	134,4
47	41,9	21,3	97	86,4	44,0	147	131,0	66,7	197	175,5	89,4	247	220,1	112,1	297	264,6	134,8
48	42,8	21,8	98	87,3	44,5	148	131,9	67,2	198	176,4	89,9	248	221,0	112,6	298	265,5	135,3
49	43,7	22,2	99	88,2	44,9	149	132,8	67,6	199	177,3	90,3	249	221,9	113,0	299	266,4	135,7
50	44,6	22,7	100	89,1	45,4	150	133,7	68,1	200	178,2	90,8	250	222,8	113,5	300	267,3	136,2
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 63 Deg.

28°. Difference of Latitude and Departure for 28 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00,9	00,5	51	45,0	23,9	101	89,2	47,4	151	133,3	70,9	201	177,5	94,4	251	221,6	117,8
2	01,8	00,9	52	45,9	24,4	102	90,1	47,9	152	134,2	71,4	202	178,4	94,8	252	222,5	118,3
3	02,6	01,4	53	46,8	24,9	103	90,9	48,4	153	135,1	71,8	203	179,2	95,3	253	223,4	118,8
4	03,5	01,9	54	47,7	25,4	104	91,8	48,8	154	136,0	72,3	204	180,1	95,8	254	224,3	119,2
5	04,4	02,3	55	48,6	25,8	105	92,7	49,3	155	136,9	72,8	205	181,0	96,2	255	225,2	119,7
6	05,3	02,8	56	49,4	26,3	106	93,6	49,8	156	137,7	73,2	206	181,9	96,7	256	226,0	120,2
7	06,2	03,3	57	50,3	26,8	107	94,5	50,2	157	138,6	73,7	207	182,8	97,2	257	226,9	120,7
8	07,1	03,8	58	51,2	27,2	108	95,4	50,7	158	139,5	74,2	208	183,7	97,7	258	227,8	121,1
9	07,9	04,3	59	52,1	27,7	109	96,2	51,2	159	140,4	74,6	209	184,5	98,1	259	228,7	121,6
10	08,8	04,7	60	53,0	28,2	110	97,1	51,6	160	141,3	75,1	210	185,4	98,6	260	229,6	122,1
11	09,7	05,2	61	53,9	28,6	111	98,0	52,1	161	142,2	75,6	211	186,3	99,1	261	230,5	122,5
12	10,6	05,6	62	54,7	29,1	112	98,9	52,6	162	143,0	76,1	212	187,2	99,5	262	231,3	123,0
13	11,5	06,1	63	55,6	29,6	113	99,8	53,1	163	143,9	76,5	213	188,1	100,0	263	232,2	123,5
14	12,4	06,6	64	56,5	30,0	114	100,7	53,5	164	144,8	77,0	214	189,0	100,5	264	233,1	123,9
15	13,2	07,0	65	57,4	30,5	115	101,5	54,0	165	145,7	77,5	215	189,8	100,9	265	234,0	124,4
16	14,1	07,5	66	58,3	31,0	116	102,4	54,5	166	146,6	77,9	216	190,7	101,4	266	234,9	124,9
17	15,0	08,0	67	59,2	31,5	117	103,3	54,9	167	147,5	78,4	217	191,6	101,9	267	235,8	125,4
18	15,9	08,5	68	60,0	31,9	118	104,2	55,4	168	148,3	78,9	218	192,5	102,4	268	236,6	125,8
19	16,8	08,9	69	60,9	32,4	119	105,1	55,9	169	149,2	79,3	219	193,4	102,8	269	237,5	126,3
20	17,7	09,4	70	61,8	32,9	120	106,0	56,3	170	150,1	79,8	220	194,3	103,3	270	238,4	126,8
21	18,5	09,9	71	62,7	33,3	121	106,8	56,8	171	151,0	80,3	221	195,1	103,8	271	239,3	127,2
22	19,4	10,3	72	63,6	33,8	122	107,7	57,3	172	151,9	80,8	222	196,0	104,2	272	240,2	127,7
23	20,3	10,8	73	64,5	34,3	123	108,6	57,7	173	152,8	81,2	223	196,9	104,7	273	241,1	128,2
24	21,2	11,3	74	65,3	34,7	124	109,5	58,2	174	153,6	81,7	224	197,8	105,2	274	241,9	128,6
25	22,1	11,7	75	66,2	35,2	125	110,4	58,7	175	154,5	82,2	225	198,7	105,6	275	242,8	129,1
26	23,0	12,2	76	67,1	35,7	126	111,3	59,2	176	155,4	82,6	226	199,6	106,1	276	243,7	129,6
27	23,8	12,7	77	68,0	36,2	127	112,1	59,6	177	156,3	83,1	227	200,4	106,6	277	244,6	130,1
28	24,7	13,1	78	68,9	36,6	128	113,0	60,1	178	157,2	83,6	228	201,3	107,0	278	245,5	130,5
29	25,6	13,6	79	69,8	37,1	129	113,9	60,6	179	158,1	84,0	229	202,2	107,5	279	246,4	131,0
30	26,5	14,1	80	70,6	37,6	130	114,8	61,0	180	158,9	84,5	230	203,1	108,0	280	247,2	131,5
31	27,4	14,6	81	71,5	38,0	131	115,7	61,5	181	159,8	84,9	231	204,0	108,5	281	248,1	131,9
32	28,3	15,0	82	72,4	38,5	132	116,6	62,0	182	160,7	85,4	232	204,9	108,9	282	249,0	132,4
33	29,1	15,5	83	73,3	39,0	133	117,4	62,4	183	161,6	85,9	233	205,7	109,4	283	249,9	132,9
34	30,0	16,0	84	74,2	39,4	134	118,3	62,9	184	162,5	86,4	234	206,6	109,9	284	250,8	133,3
35	30,9	16,4	85	75,1	39,9	135	119,2	63,4	185	163,4	86,9	235	207,5	110,3	285	251,7	133,8
36	31,8	16,9	86	75,9	40,4	136	120,1	63,9	186	164,2	87,3	236	208,4	110,8	286	252,5	134,3
37	32,7	17,4	87	76,8	40,8	137	121,0	64,3	187	165,1	87,8	237	209,3	111,3	287	253,4	134,7
38	33,6	17,8	88	77,7	41,3	138	121,9	64,8	188	166,0	88,3	238	210,2	111,7	288	254,3	135,2
39	34,4	18,3	89	78,6	41,8	139	122,7	65,3	189	166,9	88,7	239	211,0	112,2	289	255,2	135,7
40	35,3	18,8	90	79,5	42,3	140	123,6	65,7	190	167,8	89,2	240	211,9	112,7	290	256,1	136,2
41	36,2	19,2	91	80,4	42,7	141	124,5	66,2	191	168,7	89,7	241	212,8	113,1	291	257,0	136,6
42	37,1	19,7	92	81,2	43,2	142	125,4	66,7	192	169,5	90,1	242	213,7	113,6	292	257,8	137,1
43	38,0	20,2	93	82,1	43,7	143	126,3	67,1	193	170,4	90,6	243	214,6	114,1	293	258,7	137,6
44	38,9	20,7	94	83,0	44,1	144	127,2	67,6	194	171,3	91,1	244	215,5	114,6	294	259,6	138,0
45	39,7	21,1	95	83,9	44,6	145	128,0	68,1	195	172,2	91,6	245	216,3	115,0	295	260,5	138,5
46	40,6	21,6	96	84,8	45,1	146	128,9	68,5	196	173,1	92,0	246	217,2	115,5	296	261,4	139,0
47	41,5	22,1	97	85,7	45,5	147	129,8	69,0	197	174,0	92,5	247	218,1	115,9	297	262,3	139,4
48	42,4	22,5	98	86,5	46,0	148	130,7	69,5	198	174,8	93,0	248	219,0	116,4	298	263,1	139,9
49	43,3	23,0	99	87,4	46,5	149	131,6	70,0	199	175,7	93,4	249	219,9	116,9	299	264,0	140,4
50	44,2	23,5	100	88,3	47,0	150	132,5	70,4	200	176,6	93,9	250	220,8	117,4	300	264,9	140,9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 62 Deg.

29°. Difference of Latitude and Departure for 29 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,9	00,5	51	44,6	24,7	101	88,3	49,0	151	132,1	73,2	201	175,8	97,4	251	219,5	121,7
2	01,7	01,0	52	45,5	25,2	102	89,2	49,4	152	132,9	73,7	202	176,7	97,9	252	220,4	122,2
3	02,6	01,5	53	46,4	25,7	103	90,1	49,9	153	133,8	74,2	203	177,5	98,4	253	221,3	122,7
4	03,5	01,9	54	47,2	26,2	104	91,0	50,4	154	134,7	74,7	204	178,4	98,9	254	222,2	123,1
5	04,4	02,4	55	48,1	26,7	105	91,8	50,9	155	135,6	75,1	205	179,3	99,4	255	223,0	123,6
6	05,2	02,9	56	49,0	27,1	106	92,7	51,4	156	136,4	75,6	206	180,2	99,9	256	223,9	124,1
7	06,1	03,4	57	49,9	27,6	107	93,6	51,9	157	137,3	76,1	207	181,0	100,4	257	224,8	124,6
8	07,0	03,9	58	50,7	28,1	108	94,5	52,4	158	138,2	76,6	208	181,9	100,8	258	225,6	125,1
9	07,9	04,4	59	51,6	28,6	109	95,3	52,8	159	139,1	77,1	209	182,8	101,3	259	226,5	125,6
10	08,7	04,8	60	52,5	29,1	110	96,2	53,3	160	139,9	77,6	210	183,7	101,8	260	227,4	126,0
11	09,6	05,3	61	53,4	29,6	111	97,1	53,8	161	140,8	78,1	211	184,5	102,3	261	228,3	126,5
12	10,5	05,8	62	54,2	30,1	112	98,0	54,3	162	141,7	78,5	212	185,4	102,8	262	229,1	127,0
13	11,4	06,3	63	55,1	30,5	113	98,8	54,8	163	142,6	79,0	213	186,3	103,3	263	230,0	127,5
14	12,2	06,8	64	56,0	31,0	114	99,7	55,3	164	143,4	79,5	214	187,2	103,7	264	230,9	128,0
15	13,1	07,3	65	56,8	31,5	115	100,6	55,8	165	144,3	80,0	215	188,0	104,2	265	231,8	128,5
16	14,0	07,8	66	57,7	32,0	116	101,5	56,2	166	145,2	80,5	216	188,9	104,7	266	232,6	129,0
17	14,9	08,2	67	58,6	32,5	117	102,3	56,7	167	146,1	81,0	217	189,8	105,2	267	233,5	129,4
18	15,7	08,7	68	59,5	33,0	118	103,2	57,2	168	146,9	81,4	218	190,7	105,7	268	234,4	129,9
19	16,6	09,2	69	60,3	33,5	119	104,1	57,7	169	147,8	81,9	219	191,5	106,2	269	235,3	130,4
20	17,5	09,7	70	61,2	33,9	120	105,0	58,2	170	148,7	82,4	220	192,4	106,7	270	236,1	130,9
21	18,4	10,2	71	62,1	34,4	121	105,8	58,7	171	149,6	82,9	221	193,3	107,1	271	237,0	131,4
22	19,2	10,7	72	63,0	34,9	122	106,7	59,1	172	150,4	83,4	222	194,2	107,6	272	237,9	131,9
23	20,1	11,2	73	63,8	35,4	123	107,6	59,6	173	151,3	83,9	223	195,0	108,1	273	238,8	132,4
24	21,0	11,6	74	64,7	35,9	124	108,5	60,1	174	152,2	84,4	224	195,9	108,6	274	239,6	132,8
25	21,9	12,1	75	65,6	36,4	125	109,3	60,6	175	153,1	84,8	225	196,8	109,1	275	240,5	133,3
26	22,7	12,6	76	66,5	36,8	126	110,2	61,1	176	153,9	85,3	226	197,7	109,6	276	241,4	133,8
27	23,6	13,1	77	67,3	37,3	127	111,1	61,6	177	154,8	85,8	227	198,5	110,0	277	242,3	134,3
28	24,5	13,6	78	68,2	37,8	128	111,9	62,1	178	155,7	86,3	228	199,4	110,5	278	243,1	134,8
29	25,4	14,1	79	69,1	38,3	129	112,8	62,5	179	156,6	86,8	229	200,3	111,0	279	244,0	135,3
30	26,2	14,5	80	70,0	38,8	130	113,7	63,0	180	157,4	87,3	230	201,2	111,5	280	244,9	135,7
31	27,1	15,0	81	70,8	39,3	131	114,6	63,5	181	158,3	87,7	231	202,0	112,0	281	245,8	136,2
32	28,0	15,5	82	71,7	39,8	132	115,4	64,0	182	159,2	88,2	232	202,9	112,5	282	246,6	136,7
33	28,9	16,0	83	72,6	40,2	133	116,3	64,5	183	160,1	88,7	233	203,8	113,0	283	247,5	137,2
34	29,7	16,5	84	73,5	40,7	134	117,2	65,0	184	160,9	89,2	234	204,7	113,4	284	248,4	137,7
35	30,6	17,0	85	74,3	41,2	135	118,1	65,4	185	161,8	89,7	235	205,5	113,9	285	249,3	138,2
36	31,5	17,5	86	75,2	41,7	136	118,9	65,9	186	162,7	90,2	236	206,4	114,4	286	250,1	138,7
37	32,4	17,9	87	76,1	42,2	137	119,8	66,4	187	163,6	90,7	237	207,3	114,9	287	251,0	139,1
38	33,2	18,4	88	77,0	42,7	138	120,7	66,9	188	164,4	91,1	238	208,2	115,4	288	251,9	139,6
39	34,1	18,9	89	77,8	43,1	139	121,6	67,4	189	165,3	91,6	239	209,0	115,9	289	252,8	140,1
40	35,0	19,4	90	78,7	43,6	140	122,4	67,9	190	166,2	92,1	240	209,9	116,4	290	253,6	140,6
41	35,9	19,9	91	79,6	44,1	141	123,3	68,4	191	167,0	92,6	241	210,8	116,8	291	254,5	141,1
42	36,7	20,4	92	80,5	44,6	142	124,2	68,8	192	167,9	93,1	242	211,7	117,3	292	255,4	141,6
43	37,6	20,8	93	81,3	45,1	143	125,1	69,3	193	168,8	93,6	243	212,5	117,8	293	256,3	142,0
44	38,5	21,3	94	82,2	45,6	144	125,9	69,8	194	169,7	94,1	244	213,4	118,3	294	257,1	142,5
45	39,4	21,8	95	83,1	46,1	145	126,8	70,3	195	170,5	94,5	245	214,3	118,8	295	258,0	143,0
46	40,2	22,3	96	84,0	46,5	146	127,7	70,8	196	171,4	95,0	246	215,2	119,3	296	258,9	143,5
47	41,1	22,8	97	84,8	47,0	147	128,6	71,3	197	172,3	95,5	247	216,0	119,7	297	259,8	144,0
48	42,0	23,3	98	85,7	47,5	148	129,4	71,8	198	173,2	96,0	248	216,9	120,2	298	260,6	144,5
49	42,9	23,8	99	86,6	48,0	149	130,3	72,2	199	174,0	96,5	249	217,8	120,7	299	261,5	145,0
50	43,7	24,2	100	87,5	48,5	150	131,2	72,7	200	174,9	97,0	250	218,7	121,1	300	262,4	145,4
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 61 Deg.

30°. Difference of Latitude and Departure for 30 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Lat.
1	00,9	00,5	51	44,2	25,5	101	87,5	50,5	151	130,8	75,5	201	174,1	100,5	251	217,4	125,5
2	01,7	01,0	52	45,0	26,0	102	88,3	51,0	152	131,6	76,0	202	174,9	101,0	252	218,2	126,0
3	02,6	01,5	53	45,9	26,5	103	89,2	51,5	153	132,5	76,5	203	175,8	101,5	253	219,1	126,5
4	03,5	02,0	54	46,8	27,0	104	90,1	52,0	154	133,4	77,0	204	176,7	102,0	254	220,0	127,0
5	04,3	02,5	55	47,6	27,5	105	90,9	52,5	155	134,2	77,5	205	177,5	102,5	255	220,8	127,5
6	05,2	03,0	56	48,5	28,0	106	91,8	53,0	156	135,1	78,0	206	178,4	103,0	256	221,7	128,0
7	06,1	03,5	57	49,4	28,5	107	92,7	53,5	157	136,0	78,5	207	179,3	103,5	257	222,6	128,5
8	06,9	04,0	58	50,2	29,0	108	93,5	54,0	158	136,8	79,0	208	180,1	104,0	258	223,4	129,0
9	07,8	04,5	59	51,1	29,5	109	94,4	54,5	159	137,7	79,5	209	181,0	104,5	259	224,3	129,5
10	08,7	05,0	60	52,0	30,0	110	95,3	55,0	160	138,6	80,0	210	181,9	105,0	260	225,2	130,0
11	09,5	05,5	61	52,8	30,5	111	96,1	55,5	161	139,4	80,5	211	182,7	105,5	261	226,0	130,5
12	10,4	06,0	62	53,7	31,0	112	97,0	56,0	162	140,3	81,0	212	183,6	106,0	262	226,9	131,0
13	11,3	06,5	63	54,6	31,5	113	97,9	56,5	163	141,2	81,5	213	184,5	106,5	263	227,8	131,5
14	12,1	07,0	64	55,4	32,0	114	98,7	57,0	164	142,0	82,0	214	185,3	107,0	264	228,6	132,0
15	13,0	07,5	65	56,3	32,5	115	99,6	57,5	165	142,9	82,5	215	186,2	107,5	265	229,5	132,5
16	13,9	08,0	66	57,2	33,0	116	100,5	58,0	166	143,8	83,0	216	187,1	108,0	266	230,4	133,0
17	14,7	08,5	67	58,0	33,5	117	101,3	58,5	167	144,6	83,5	217	187,9	108,5	267	231,2	133,5
18	15,6	09,0	68	58,9	34,0	118	102,2	59,0	168	145,5	84,0	218	188,8	109,0	268	232,1	134,0
19	16,5	09,5	69	59,8	34,5	119	103,1	59,5	169	146,4	84,5	219	189,7	109,5	269	233,0	134,5
20	17,3	10,0	70	60,6	35,0	120	103,9	60,0	170	147,2	85,0	220	190,5	110,0	270	233,8	135,0
21	18,2	10,5	71	61,5	35,5	121	104,8	60,5	171	148,1	85,5	221	191,4	110,5	271	234,7	135,5
22	19,1	11,0	72	62,4	36,0	122	105,7	61,0	172	149,0	86,0	222	192,3	111,0	272	235,6	136,0
23	19,9	11,5	73	63,2	36,5	123	106,5	61,5	173	149,8	86,5	223	193,1	111,5	273	236,4	136,5
24	20,8	12,0	74	64,1	37,0	124	107,4	62,0	174	150,7	87,0	224	194,0	112,0	274	237,3	137,0
25	21,7	12,5	75	65,0	37,5	125	108,3	62,5	175	151,6	87,5	225	194,9	112,5	275	238,2	137,5
26	22,5	13,0	76	65,8	38,0	126	109,1	63,0	176	152,4	88,0	226	195,7	113,0	276	239,0	138,0
27	23,4	13,5	77	66,7	38,5	127	110,0	63,5	177	153,3	88,5	227	196,6	113,5	277	239,9	138,5
28	24,2	14,0	78	67,5	39,0	128	110,8	64,0	178	154,1	89,0	228	197,4	114,0	278	240,7	139,0
29	25,1	14,5	79	68,4	39,5	129	111,7	64,5	179	155,0	89,5	229	198,3	114,5	279	241,6	139,5
30	26,0	15,0	80	69,3	40,0	130	112,6	65,0	180	155,9	90,0	230	199,2	115,0	280	242,5	140,0
31	26,8	15,5	81	70,1	40,5	131	113,4	65,5	181	156,7	90,5	231	200,0	115,5	281	243,3	140,5
32	27,7	16,0	82	71,0	41,0	132	114,3	66,0	182	157,6	91,0	232	200,9	116,0	282	244,2	141,0
33	28,6	16,5	83	71,9	41,5	133	115,2	66,5	183	158,5	91,5	233	201,8	116,5	283	245,1	141,5
34	29,4	17,0	84	72,7	42,0	134	116,0	67,0	184	159,3	92,0	234	202,6	117,0	284	245,9	142,0
35	30,3	17,5	85	73,6	42,5	135	116,9	67,5	185	160,2	92,5	235	203,5	117,5	285	246,8	142,5
36	31,2	18,0	86	74,5	43,0	136	117,8	68,0	186	161,1	93,0	236	204,4	118,0	286	247,7	143,0
37	32,0	18,5	87	75,3	43,5	137	118,6	68,5	187	161,9	93,5	237	205,2	118,5	287	248,5	143,5
38	32,9	19,0	88	76,2	44,0	138	119,5	69,0	188	162,8	94,0	238	206,1	119,0	288	249,4	144,0
39	33,8	19,5	89	77,1	44,5	139	120,4	69,5	189	163,7	94,5	239	207,0	119,5	289	250,3	144,5
40	34,6	20,0	90	77,9	45,0	140	121,2	70,0	190	164,5	95,0	240	207,8	120,0	290	251,1	145,0
41	35,5	20,5	91	78,8	45,5	141	122,1	70,5	191	165,4	95,5	241	208,7	120,5	291	252,0	145,5
42	36,4	21,0	92	79,7	46,0	142	123,0	71,0	192	166,3	96,0	242	209,6	121,0	292	252,9	146,0
43	37,2	21,5	93	80,5	46,5	143	123,8	71,5	193	167,1	96,5	243	210,4	121,5	293	253,7	146,5
44	38,1	22,0	94	81,4	47,0	144	124,7	72,0	194	168,0	97,0	244	211,3	122,0	294	254,6	147,0
45	39,0	22,5	95	82,3	47,5	145	125,6	72,5	195	168,9	97,5	245	212,2	122,5	295	255,5	147,5
46	39,8	23,0	96	83,1	48,0	146	126,4	73,0	196	169,7	98,0	246	213,0	123,0	296	256,3	148,0
47	40,7	23,5	97	84,0	48,5	147	127,3	73,5	197	170,6	98,5	247	213,9	123,5	297	257,2	148,5
48	41,6	24,0	98	84,9	49,0	148	128,2	74,0	198	171,5	99,0	248	214,8	124,0	298	258,1	149,0
49	42,4	24,5	99	85,7	49,5	149	129,0	74,5	199	172,3	99,5	249	215,6	124,5	299	258,9	149,5
50	43,3	25,0	100	86,6	50,0	150	129,9	75,0	200	173,2	100,0	250	216,5	125,0	300	259,8	150,0
Dift.	Dep.	La	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Dep.

Difference of Lat. and Dep. for 60 Deg.

31°. Difference of Latitude and Departure for 31 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,9	00,5	51	43,7	26,3	101	86,6	52,0	151	129,4	77,8	201	172,3	103,5	251	215,1	129,3
2	01,7	01,0	52	44,6	26,8	102	87,4	52,5	152	130,3	78,3	202	173,1	104,0	252	216,0	129,8
3	02,6	01,5	53	45,4	27,3	103	88,3	53,0	153	131,1	78,8	203	174,0	104,5	253	216,8	130,3
4	03,5	02,1	54	46,3	27,8	104	89,1	53,6	154	132,0	79,3	204	174,8	105,1	254	217,7	130,8
5	04,3	02,6	55	47,1	28,3	105	90,0	54,1	155	132,8	79,8	205	175,7	105,6	255	218,5	131,3
6	05,1	03,1	56	48,0	28,8	106	90,8	54,6	156	133,7	80,3	206	176,5	106,1	256	219,4	131,8
7	06,0	03,6	57	48,8	29,4	107	91,7	55,1	157	134,5	80,9	207	177,4	106,6	257	220,2	132,4
8	06,9	04,1	58	49,7	29,9	108	92,6	55,6	158	135,4	81,4	208	178,3	107,1	258	221,1	132,9
9	07,7	04,6	59	50,6	30,4	109	93,4	56,1	159	136,3	81,9	209	179,1	107,6	259	222,0	133,4
10	08,6	05,2	60	51,4	30,9	110	94,3	56,7	160	137,1	82,4	210	180,0	108,2	260	222,8	133,9
11	09,4	05,7	61	52,3	31,4	111	95,1	57,2	161	138,0	82,9	211	180,8	108,7	261	223,7	134,4
12	10,3	06,2	62	53,1	31,9	112	96,0	57,7	162	138,8	83,4	212	181,7	109,2	262	224,5	134,9
13	11,1	06,7	63	54,0	32,4	113	96,8	58,2	163	139,7	83,9	213	182,5	109,7	263	225,4	135,4
14	12,0	07,2	64	54,8	33,0	114	97,7	58,7	164	140,5	84,5	214	183,4	110,2	264	226,2	136,0
15	12,9	07,7	65	55,7	33,5	115	98,6	59,2	165	141,4	85,0	215	184,3	110,7	265	227,1	136,5
16	13,7	08,2	66	56,6	34,0	116	99,4	59,7	166	142,3	85,5	216	185,1	111,2	266	228,0	137,0
17	14,6	08,8	67	57,4	34,5	117	100,3	60,3	167	143,1	86,0	217	186,0	111,8	267	228,8	137,5
18	15,4	09,3	68	58,3	35,0	118	101,1	60,8	168	144,0	86,5	218	186,8	112,3	268	229,7	138,0
19	16,3	09,8	69	59,1	35,5	119	102,0	61,3	169	144,8	87,0	219	187,7	112,8	269	230,5	138,5
20	17,1	10,3	70	60,0	36,1	120	102,8	61,8	170	145,7	87,6	220	188,5	113,3	270	231,4	139,1
21	18,0	10,8	71	60,8	36,6	121	103,7	62,3	171	146,5	88,1	221	189,4	113,8	271	232,2	139,6
22	18,9	11,3	72	61,7	37,1	122	104,6	62,8	172	147,4	88,6	222	190,3	114,3	272	233,1	140,1
23	19,7	11,8	73	62,6	37,6	123	105,4	63,3	173	148,3	89,1	223	191,1	114,8	273	234,0	140,6
24	20,6	12,4	74	63,4	38,1	124	106,3	63,9	174	149,1	89,6	224	192,0	115,4	274	234,8	141,1
25	21,4	12,9	75	64,3	38,6	125	107,1	64,4	175	150,0	90,1	225	192,8	115,9	275	235,7	141,6
26	22,3	13,4	76	65,1	39,1	126	108,0	64,9	176	150,8	90,6	226	193,7	116,4	276	236,5	142,1
27	23,1	13,9	77	66,0	39,7	127	108,8	65,4	177	151,7	91,2	227	194,5	116,9	277	237,4	142,7
28	24,0	14,4	78	66,8	40,2	128	109,7	65,9	178	152,5	91,7	228	195,4	117,4	278	238,2	143,2
29	24,9	14,9	79	67,7	40,7	129	110,6	66,4	179	153,4	92,2	229	196,3	117,9	279	239,1	143,7
30	25,7	15,5	80	68,6	41,2	130	111,4	67,0	180	154,3	92,7	230	197,1	118,5	280	240,0	144,2
31	26,6	16,0	81	69,4	41,7	131	112,3	67,5	181	155,1	93,2	231	198,0	119,0	281	240,8	144,7
32	27,4	16,5	82	70,3	42,2	132	113,1	68,0	182	156,0	93,7	232	198,8	119,5	282	241,7	145,2
33	28,3	17,0	83	71,1	42,7	133	114,0	68,5	183	156,8	94,2	233	199,7	120,0	283	242,5	145,7
34	29,1	17,5	84	72,0	43,2	134	114,8	69,0	184	157,7	94,8	234	200,5	120,5	284	243,4	146,3
35	30,0	18,0	85	72,8	43,8	135	115,7	69,5	185	158,5	95,3	235	201,4	121,0	285	244,2	146,8
36	30,9	18,5	86	73,7	44,3	136	116,6	70,0	186	159,4	95,8	236	202,3	121,5	286	245,1	147,3
37	31,7	19,1	87	74,6	44,8	137	117,4	70,6	187	160,3	96,3	237	203,1	122,1	287	246,0	147,8
38	32,6	19,6	88	75,4	45,3	138	118,3	71,1	188	161,1	96,8	238	204,0	122,6	288	246,8	148,3
39	33,4	20,1	89	76,3	45,8	139	119,1	71,6	189	162,0	97,3	239	204,8	123,1	289	247,7	148,8
40	34,3	20,6	90	77,1	46,4	140	120,0	72,1	190	162,8	97,9	240	205,7	123,6	290	248,5	149,4
41	35,1	21,1	91	78,0	46,9	141	120,8	72,6	191	163,7	98,4	241	206,5	124,1	291	249,4	149,9
42	36,0	21,6	92	78,8	47,4	142	121,7	73,1	192	164,5	98,9	242	207,4	124,6	292	250,2	150,4
43	36,9	22,1	93	79,7	47,9	143	122,6	73,6	193	165,4	99,4	243	208,3	125,1	293	251,1	150,9
44	37,7	22,6	94	80,6	48,4	144	123,4	74,2	194	166,3	99,9	244	209,1	125,6	294	252,0	151,4
45	38,6	23,2	95	81,4	48,5	145	124,3	74,7	195	167,1	100,4	245	210,0	126,2	295	252,8	151,9
46	39,4	23,7	96	82,3	49,4	146	125,1	75,2	196	168,0	100,9	246	210,8	126,7	296	253,7	152,4
47	40,3	24,2	97	83,1	50,0	147	126,0	75,7	197	168,8	101,5	247	211,7	127,2	297	254,5	153,0
48	41,1	24,7	98	84,0	50,5	148	126,8	76,2	198	169,7	102,0	248	212,5	127,7	298	255,4	153,5
49	42,0	25,2	99	84,8	51,0	149	127,7	76,7	199	170,5	102,5	249	213,4	128,2	299	256,2	154,0
50	42,9	25,8	100	85,7	51,5	150	128,6	77,3	200	171,4	103,0	250	214,3	128,8	300	257,1	154,5
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 59 Deg.

32°. Difference of Latitude and Departure for 32 Deg.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00,8	00,5	51	43,2	27,0	101	85,6	53,5	151	128,0	80,0	201	170,4	106,5	251	212,8	133,0
2	01,7	01,1	52	44,1	27,6	102	86,5	54,1	152	128,9	80,6	202	171,5	107,1	252	213,7	133,6
3	02,5	01,6	53	44,9	28,1	103	87,3	54,6	153	129,7	81,1	203	172,1	107,6	253	214,5	134,1
4	03,4	02,1	54	45,8	28,6	104	88,2	55,1	154	130,6	81,6	204	173,0	108,1	254	215,4	134,6
5	04,2	02,7	55	46,6	29,2	105	89,0	55,7	155	131,4	82,2	205	173,8	108,7	255	216,2	135,2
6	05,1	03,2	56	47,5	29,7	106	89,9	56,2	156	132,3	82,7	206	174,7	109,2	256	217,1	135,7
7	05,9	03,7	57	48,3	30,2	107	90,7	56,7	157	133,1	83,2	207	175,5	109,7	257	217,9	136,2
8	06,8	04,2	58	49,2	30,7	108	91,6	57,2	158	134,0	83,7	208	176,4	110,2	258	218,8	136,7
9	07,6	04,8	59	50,0	31,3	109	92,4	57,8	159	134,8	84,3	209	177,2	110,8	259	219,6	137,3
10	08,5	05,3	60	50,9	31,8	110	93,3	58,3	160	135,7	84,8	210	178,1	111,3	260	220,5	137,8
11	09,3	05,8	61	51,7	32,3	111	94,1	58,8	161	136,5	85,3	211	178,9	111,8	261	221,3	138,3
12	10,2	06,4	62	52,6	32,9	112	95,0	59,4	162	137,4	85,9	212	179,8	112,4	262	222,2	138,9
13	11,0	06,9	63	53,4	33,4	113	95,8	59,9	163	138,2	86,4	213	180,6	112,9	263	223,0	139,4
14	11,9	07,4	64	54,3	33,9	114	96,7	60,4	164	139,1	86,9	214	181,5	113,4	264	223,9	139,9
15	12,7	08,0	65	55,1	34,5	115	97,5	61,0	165	139,9	87,5	215	182,3	114,0	265	224,7	140,5
16	13,6	08,5	66	56,0	35,0	116	98,4	61,5	166	140,8	88,0	216	183,2	114,5	266	225,6	141,0
17	14,4	09,0	67	56,8	35,5	117	99,2	62,0	167	141,6	88,5	217	184,0	115,0	267	226,4	141,5
18	15,3	09,5	68	57,7	36,0	118	100,1	62,5	168	142,5	89,0	218	184,9	115,5	268	227,3	142,0
19	16,1	10,1	69	58,5	36,6	119	100,9	63,1	169	143,3	89,6	219	185,7	116,1	269	228,1	142,6
20	17,0	10,6	70	59,4	37,1	120	101,8	63,6	170	144,2	90,1	220	186,6	116,6	270	229,0	143,1
21	17,8	11,1	71	60,2	37,6	121	102,6	64,1	171	145,0	90,6	221	187,4	117,1	271	229,8	143,6
22	18,7	11,7	72	61,1	38,2	122	103,5	64,7	172	145,9	91,2	222	188,3	117,7	272	230,7	144,2
23	19,5	12,2	73	61,9	38,7	123	104,3	65,2	173	146,7	91,7	223	189,1	118,2	273	231,5	144,7
24	20,4	12,7	74	62,8	39,2	124	105,2	65,7	174	147,6	92,2	224	190,0	118,7	274	232,4	145,2
25	21,2	13,3	75	63,6	39,8	125	106,0	66,3	175	148,4	92,8	225	190,8	119,3	275	233,2	145,8
26	22,0	13,8	76	64,4	40,3	126	106,8	66,8	176	149,2	93,3	226	191,6	119,8	276	234,0	146,3
27	22,9	14,3	77	65,3	40,8	127	107,7	67,3	177	150,1	93,8	227	192,5	120,3	277	234,9	146,8
28	23,7	14,8	78	66,1	41,3	128	108,5	67,8	178	150,9	94,3	228	193,3	120,8	278	235,7	147,3
29	24,6	15,4	79	67,0	41,9	129	109,4	68,4	179	151,8	94,9	229	194,2	121,4	279	236,6	147,9
30	25,4	15,9	80	67,8	42,4	130	110,2	68,9	180	152,6	95,4	230	195,0	121,9	280	237,4	148,4
31	26,3	16,4	81	68,7	42,9	131	111,1	69,4	181	153,5	95,9	231	195,9	122,4	281	238,3	148,9
32	27,1	17,0	82	69,5	43,5	132	111,9	70,0	182	154,3	96,5	232	196,7	123,0	282	239,1	149,5
33	28,0	17,5	83	70,4	44,0	133	112,8	70,5	183	155,2	97,0	233	197,6	123,5	283	240,0	150,0
34	28,8	18,0	84	71,2	44,5	134	113,6	71,0	184	156,0	97,5	234	198,4	124,0	284	240,8	150,5
35	29,7	18,6	85	72,1	45,1	135	114,5	71,6	185	156,9	98,1	235	199,3	124,6	285	241,7	151,1
36	30,5	19,1	86	72,9	45,6	136	115,3	72,1	186	157,7	98,6	236	200,1	125,1	286	242,5	151,6
37	31,4	19,6	87	73,8	46,1	137	116,2	72,6	187	158,6	99,1	237	201,0	125,6	287	243,4	152,1
38	32,2	20,1	88	74,6	46,6	138	117,0	73,1	188	159,4	99,6	238	201,8	126,1	288	244,2	152,6
39	33,1	20,7	89	75,5	47,2	139	117,9	73,7	189	160,3	100,2	239	202,7	126,7	289	245,1	153,2
40	33,9	21,2	90	76,3	47,7	140	118,7	74,2	190	161,1	100,7	240	203,5	127,2	290	245,9	153,7
41	34,8	21,7	91	77,2	48,2	141	119,6	74,7	191	162,0	101,2	241	204,4	127,7	291	246,8	154,2
42	35,6	22,3	92	78,0	48,8	142	120,4	75,3	192	162,8	101,8	242	205,2	128,3	292	247,6	154,8
43	36,5	22,8	93	78,9	49,3	143	121,3	75,8	193	163,7	102,3	243	206,1	128,8	293	248,5	155,3
44	37,3	23,3	94	79,7	49,8	144	122,1	76,3	194	164,5	102,8	244	206,9	129,3	294	249,3	155,8
45	38,2	23,9	95	80,6	50,4	145	123,0	76,9	195	165,4	103,4	245	207,8	129,9	295	250,2	156,4
46	39,0	24,4	96	81,4	50,9	146	123,8	77,4	196	166,2	103,9	246	208,6	130,4	296	251,0	156,9
47	39,9	24,9	97	82,3	51,4	147	124,7	77,9	197	167,1	104,4	247	209,5	130,9	297	251,9	157,4
48	40,7	25,4	98	83,1	51,9	148	125,5	78,4	198	167,9	104,9	248	210,3	131,4	298	252,7	157,9
49	41,6	26,0	99	84,0	52,5	149	126,4	79,0	199	168,8	105,5	249	211,2	132,0	299	253,6	158,5
50	42,4	26,5	100	84,8	53,0	150	127,2	79,5	200	169,6	106,0	250	212,0	132,5	300	254,4	159,0
i	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

Difference of Lat. and Dep. for 58 Deg.

33°. Difference of Latitude and Departure for 33 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,8	00,5	51	42,8	27,8	101	84,7	55,0	151	126,6	82,2	201	168,6	109,5	251	210,5	136,7
2	01,7	01,1	52	43,6	28,3	102	85,5	55,5	152	127,5	82,8	202	169,4	110,0	252	211,3	137,2
3	02,5	01,6	53	44,4	28,9	103	86,4	56,1	153	128,3	83,3	203	170,2	110,6	253	212,2	137,8
4	03,4	02,2	54	45,3	29,4	104	87,2	56,6	154	129,1	83,9	204	171,1	111,1	254	213,0	138,3
5	04,2	02,7	55	46,1	30,0	105	88,1	57,2	155	130,0	84,4	205	171,9	111,6	255	213,8	138,9
6	05,0	03,3	56	47,0	30,5	106	88,9	57,7	156	130,8	85,0	206	172,8	112,2	256	214,7	139,4
7	05,9	03,8	57	47,8	31,0	107	89,7	58,3	157	131,7	85,5	207	173,6	112,7	257	215,5	140,0
8	06,7	04,3	58	48,6	31,6	108	90,6	58,8	158	132,5	86,0	208	174,4	113,3	258	216,4	140,5
9	07,5	04,9	59	49,5	32,1	109	91,4	59,4	159	133,3	86,6	209	175,3	113,8	259	217,2	141,1
10	08,4	05,4	60	50,3	32,7	110	92,2	59,9	160	134,2	87,1	210	176,1	114,4	260	218,0	141,6
11	09,2	06,0	61	51,2	33,2	111	93,1	60,5	161	135,0	87,7	211	176,9	114,9	261	218,9	142,1
12	10,1	06,5	62	52,0	33,8	112	93,9	61,0	162	135,9	88,2	212	177,8	115,5	262	219,7	142,7
13	10,9	07,1	63	52,8	34,3	113	94,8	61,5	163	136,7	88,8	213	178,6	116,0	263	220,6	143,2
14	11,7	07,6	64	53,7	34,9	114	95,6	62,1	164	137,5	89,3	214	179,5	116,5	264	221,4	143,8
15	12,6	08,2	65	54,5	35,4	115	96,4	62,6	165	138,4	89,9	215	180,3	117,1	265	222,2	144,3
16	13,4	08,7	66	55,3	35,9	116	97,3	63,2	166	139,2	90,4	216	181,1	117,6	266	223,1	144,9
17	14,3	09,3	67	56,2	36,5	117	98,1	63,7	167	140,0	90,9	217	182,0	118,2	267	223,9	145,4
18	15,1	09,8	68	57,0	37,0	118	99,0	64,3	168	140,9	91,5	218	182,8	118,7	268	224,7	146,0
19	15,9	10,3	69	57,9	37,6	119	99,8	64,8	169	141,7	92,0	219	183,7	119,3	269	225,6	146,5
20	16,8	10,9	70	58,7	38,1	120	100,6	65,4	170	142,6	92,6	220	184,5	119,8	270	226,4	147,0
21	17,6	11,4	71	59,5	38,7	121	101,5	65,9	171	143,4	93,1	221	185,3	120,4	271	227,3	147,6
22	18,4	12,0	72	60,4	39,2	122	102,3	66,4	172	144,2	93,7	222	186,2	120,9	272	228,1	148,1
23	19,3	12,5	73	61,2	39,8	123	103,1	67,0	173	145,1	94,2	223	187,0	121,4	273	228,9	148,7
24	20,1	13,1	74	62,1	40,3	124	104,0	67,5	174	145,9	94,8	224	187,8	122,0	274	229,8	149,2
25	21,0	13,6	75	62,9	40,8	125	104,8	68,1	175	146,8	95,3	225	188,7	122,5	275	230,6	149,8
26	21,8	14,2	76	63,7	41,4	126	105,7	68,6	176	147,6	95,8	226	189,5	123,1	276	231,5	150,3
27	22,6	14,7	77	64,6	41,9	127	106,5	69,2	177	148,4	96,4	227	190,4	123,6	277	232,3	150,9
28	23,5	15,2	78	65,4	42,5	128	107,3	69,7	178	149,3	96,9	228	191,2	124,2	278	233,1	151,4
29	24,3	15,8	79	66,2	43,0	129	108,2	70,3	179	150,1	97,5	229	192,0	124,7	279	234,0	151,9
30	25,2	16,3	80	67,1	43,6	130	109,0	70,8	180	150,9	98,0	230	192,9	125,3	280	234,8	152,5
31	26,0	16,9	81	67,9	44,1	131	109,9	71,3	181	151,8	98,6	231	193,7	125,8	281	235,6	153,0
32	26,8	17,4	82	68,8	44,7	132	110,7	71,9	182	152,6	99,1	232	194,6	126,3	282	236,5	153,6
33	27,7	18,0	83	69,6	45,2	133	111,5	72,4	183	153,5	99,7	233	195,4	126,9	283	237,3	154,1
34	28,5	18,5	84	70,4	45,7	134	112,4	73,0	184	154,3	100,2	234	196,2	127,4	284	238,2	154,7
35	29,4	19,1	85	71,3	46,3	135	113,2	73,5	185	155,1	100,8	235	197,1	128,0	285	239,0	155,2
36	30,2	19,6	86	72,1	46,8	136	114,0	74,1	186	156,0	101,3	236	197,9	128,5	286	239,8	155,8
37	31,0	20,2	87	73,0	47,4	137	114,9	74,6	187	156,8	101,8	237	198,7	129,1	287	240,7	156,3
38	31,9	20,7	88	73,8	47,9	138	115,7	75,2	188	157,7	102,4	238	199,6	129,6	288	241,5	156,8
39	32,7	21,2	89	74,6	48,5	139	116,6	75,7	189	158,5	102,9	239	200,4	130,2	289	242,4	157,4
40	33,5	21,8	90	75,5	49,0	140	117,4	76,2	190	159,3	103,5	240	201,3	130,7	290	243,2	157,9
41	34,4	22,3	91	76,3	49,6	141	118,2	76,8	191	160,2	104,0	241	202,1	131,2	291	244,0	158,5
42	35,2	22,9	92	77,2	50,1	142	119,1	77,3	192	161,0	104,6	242	202,9	131,8	292	244,9	159,0
43	36,1	23,4	93	78,0	50,6	143	119,8	77,9	193	161,8	105,1	243	203,8	132,3	293	245,7	159,6
44	36,9	24,0	94	78,8	51,2	144	120,8	78,4	194	162,7	105,7	244	204,6	132,9	294	246,5	160,1
45	37,7	24,5	95	79,7	51,7	145	121,6	79,0	195	163,5	106,2	245	205,5	133,4	295	247,4	160,7
46	38,6	25,1	96	80,5	52,3	146	122,4	79,5	196	164,4	106,7	246	206,3	134,0	296	248,2	161,2
47	39,4	25,6	97	81,3	52,8	147	123,3	80,1	197	165,2	107,3	247	207,1	134,5	297	249,1	161,7
48	40,3	26,1	98	82,2	53,4	148	124,1	80,6	198	166,0	107,8	248	208,0	135,1	298	249,9	162,3
49	41,1	26,7	99	83,0	53,9	149	125,0	81,1	199	166,9	108,4	249	208,8	135,6	299	250,7	162,8
50	41,9	27,2	100	83,9	54,5	150	125,8	81,7	200	167,7	108,9	250	209,7	136,2	300	251,6	163,4
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	L. at.

Difference of Lat. and Dep. for 57 Deg.

34°. Difference of Latitude and Departure for 34 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,8	00,6	51	42,3	28,5	101	83,7	56,5	151	125,2	84,4	201	166,6	112,4	251	208,1	140,4
2	01,7	01,1	52	43,1	29,1	102	84,6	57,0	152	126,0	85,0	202	167,5	113,0	252	208,9	140,9
3	02,5	01,7	53	43,9	29,6	103	85,4	57,6	153	126,8	85,6	203	168,3	113,5	253	209,7	141,5
4	03,3	02,2	54	44,8	30,2	104	86,2	58,2	154	127,7	86,1	204	169,1	114,1	254	210,6	142,0
5	04,1	02,8	55	45,6	30,8	105	87,0	58,7	155	128,5	86,7	205	169,9	114,6	255	211,4	142,6
6	05,0	03,4	56	46,4	31,3	106	87,9	59,3	156	129,3	87,2	206	170,8	115,2	256	212,2	143,2
7	05,8	03,9	57	47,3	31,9	107	88,7	59,8	157	130,2	87,8	207	171,6	115,8	257	213,1	143,7
8	06,6	04,5	58	48,1	32,4	108	89,5	60,4	158	131,0	88,4	208	172,4	116,3	258	213,9	144,3
9	07,5	05,0	59	48,9	33,0	109	90,4	61,0	159	131,8	88,9	209	173,3	116,9	259	214,7	144,8
10	08,3	05,6	60	49,7	33,6	110	91,2	61,5	160	132,6	89,5	210	174,1	117,4	260	215,5	145,4
11	09,1	06,2	61	50,6	34,1	111	92,0	62,1	161	133,5	90,0	211	174,9	118,0	261	216,4	146,0
12	09,9	06,7	62	51,4	34,7	112	92,8	62,6	162	134,3	90,6	212	175,7	118,6	262	217,2	146,5
13	10,8	07,3	63	52,2	35,2	113	93,7	63,2	163	135,1	91,1	213	176,6	119,1	263	218,0	147,1
14	11,6	07,8	64	53,1	35,8	114	94,5	63,7	164	136,0	91,7	214	177,4	119,7	264	218,9	147,6
15	12,4	08,4	65	53,9	36,3	115	95,3	64,3	165	136,8	92,3	215	178,2	120,2	265	219,7	148,2
16	13,3	08,9	66	54,7	36,9	116	96,2	64,9	166	137,6	92,8	216	179,1	120,8	266	220,5	148,7
17	14,1	09,5	67	55,5	37,5	117	97,0	65,4	167	138,4	93,4	217	179,9	121,3	267	221,3	149,3
18	14,9	10,1	68	56,4	38,0	118	97,8	66,0	168	139,3	93,9	218	180,7	121,9	268	222,2	149,9
19	15,8	10,6	69	57,2	38,6	119	98,7	66,5	169	140,1	94,5	219	181,6	122,5	269	223,0	150,4
20	16,6	11,2	70	58,0	39,1	120	99,5	67,1	170	140,9	95,1	220	182,4	123,0	270	223,8	151,0
21	17,4	11,7	71	58,9	39,7	121	100,3	67,7	171	141,8	95,6	221	183,2	123,6	271	224,7	151,5
22	18,2	12,3	72	59,7	40,3	122	101,1	68,2	172	142,6	96,2	222	184,0	124,1	272	225,5	152,1
23	19,1	12,9	73	60,5	40,8	123	102,0	68,8	173	143,4	96,7	223	184,9	124,7	273	226,3	152,7
24	19,9	13,4	74	61,3	41,4	124	102,8	69,3	174	144,2	97,3	224	185,7	125,3	274	227,1	153,2
25	20,7	14,0	75	62,2	41,9	125	103,6	69,9	175	145,1	97,9	225	186,5	125,8	275	228,0	153,8
26	21,6	14,5	76	63,0	42,5	126	104,5	70,5	176	145,9	98,4	226	187,4	126,4	276	228,8	154,3
27	22,4	15,1	77	63,8	43,1	127	105,3	71,0	177	146,7	99,0	227	188,2	126,9	277	229,6	154,9
28	23,2	15,7	78	64,7	43,6	128	106,1	71,6	178	147,6	99,5	228	189,0	127,5	278	230,5	155,5
29	24,0	16,2	79	65,5	44,2	129	106,9	72,1	179	148,4	100,1	229	189,8	128,1	279	231,3	156,0
30	24,9	16,8	80	66,3	44,7	130	107,8	72,7	180	149,2	100,7	230	190,7	128,6	280	232,1	156,6
31	25,7	17,3	81	67,1	45,3	131	108,6	73,3	181	150,0	101,2	231	191,5	129,2	281	232,9	157,1
32	26,5	17,9	82	68,0	45,9	132	109,4	73,8	182	150,9	101,8	232	192,3	129,7	282	233,8	157,7
33	27,4	18,5	83	68,8	46,4	133	110,3	74,4	183	151,7	102,3	233	193,2	130,3	283	234,6	158,3
34	28,2	19,0	84	69,6	47,0	134	111,1	74,9	184	152,5	102,9	234	194,0	130,9	284	235,4	158,8
35	29,0	19,6	85	70,5	47,5	135	111,9	75,5	185	153,4	103,5	235	194,8	131,4	285	236,3	159,4
36	29,8	20,1	86	71,3	48,1	136	112,7	76,1	186	154,2	104,0	236	195,6	132,0	286	237,1	159,9
37	30,7	20,7	87	72,1	48,7	137	113,6	76,6	187	155,0	104,6	237	196,5	132,5	287	237,9	160,5
38	31,5	21,2	88	73,0	49,2	138	114,4	77,2	188	155,9	105,1	238	197,3	133,1	288	238,8	161,0
39	32,3	21,8	89	73,8	49,8	139	115,2	77,7	189	156,7	105,7	239	198,1	133,6	289	239,6	161,6
40	33,2	22,4	90	74,6	50,3	140	116,1	78,2	190	157,5	106,2	240	199,0	134,2	290	240,4	162,2
41	34,0	22,9	91	75,4	50,9	141	116,9	78,8	191	158,3	106,8	241	199,8	134,8	291	241,2	162,7
42	34,8	23,5	92	76,3	51,4	142	117,7	79,4	192	159,2	107,4	242	200,6	135,3	292	242,1	163,3
43	35,6	24,0	93	77,1	52,0	143	118,5	80,0	193	160,0	107,9	243	201,4	135,9	293	242,9	163,8
44	36,5	24,6	94	77,9	52,6	144	119,4	80,5	194	160,8	108,5	244	202,3	136,4	294	243,7	164,4
45	37,3	25,2	95	78,8	53,1	145	120,2	81,1	195	161,7	109,0	245	203,1	137,0	295	244,6	165,0
46	38,1	25,7	96	79,6	53,7	146	121,0	81,6	196	162,5	109,6	246	203,9	137,6	296	245,4	165,5
47	39,0	26,3	97	80,4	54,2	147	121,9	82,2	197	163,3	110,2	247	204,8	138,1	297	246,2	166,1
48	39,8	26,8	98	81,2	54,8	148	122,7	82,8	198	164,1	110,7	248	205,6	138,7	298	247,0	166,6
49	40,6	27,4	99	82,1	55,4	149	123,5	83,3	199	165,0	111,3	249	206,4	139,2	299	247,9	167,2
50	41,5	28,0	100	82,9	55,9	150	124,4	83,9	200	165,8	111,8	250	207,3	139,8	300	248,7	167,8
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 56 Deg.

35°. Difference of Latitude and Departure for 35 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Lat.
1	00,8	00,6	51	41,8	29,2	101	82,7	57,9	151	123,7	86,6	201	164,6	115,3	251	205,6	143,9
2	01,6	01,1	52	42,6	29,8	102	83,5	58,5	152	124,5	87,2	202	165,4	115,8	252	206,4	144,5
3	02,5	01,7	53	43,4	30,4	103	84,4	59,1	153	125,3	87,7	203	166,3	116,4	253	207,2	145,1
4	03,3	02,3	54	44,2	31,0	104	85,2	59,6	154	126,1	88,3	204	167,1	117,0	254	208,0	145,7
5	04,1	02,9	55	45,0	31,5	105	86,0	60,2	155	126,9	88,9	205	167,9	117,6	255	208,8	146,2
6	04,9	03,4	56	45,9	32,1	106	86,8	60,8	156	127,8	89,5	206	168,7	118,1	256	209,6	146,8
7	05,7	04,0	57	46,7	32,7	107	87,6	61,4	157	128,6	90,0	207	169,5	118,7	257	210,5	147,4
8	06,6	04,6	58	47,5	33,3	108	88,5	61,9	158	129,4	90,6	208	170,3	119,3	258	211,3	148,0
9	07,4	05,2	59	48,3	33,8	109	89,3	62,5	159	130,2	91,2	209	171,2	119,9	259	212,1	148,5
10	08,2	05,7	60	49,1	34,4	110	90,1	63,1	160	131,0	91,8	210	172,0	120,4	260	212,9	149,1
11	09,0	06,3	61	50,0	35,0	111	90,9	63,7	161	131,9	92,3	211	172,8	121,0	261	213,8	149,7
12	09,8	06,9	62	50,8	35,6	112	91,7	64,2	162	132,7	92,9	212	173,6	121,6	262	214,6	150,3
13	10,6	07,5	63	51,6	36,1	113	92,5	64,8	163	133,5	93,5	213	174,4	122,2	263	215,4	150,8
14	11,5	08,0	64	52,4	36,7	114	93,4	65,4	164	134,3	94,1	214	175,3	122,7	264	216,2	151,4
15	12,3	08,6	65	53,2	37,3	115	94,2	66,0	165	135,1	94,6	215	176,1	123,3	265	217,0	152,0
16	13,1	09,2	66	54,1	37,9	116	95,0	66,5	166	136,0	95,2	216	176,9	123,9	266	217,8	152,6
17	13,9	09,7	67	54,9	38,4	117	95,8	67,1	167	136,8	95,8	217	177,7	124,4	267	218,7	153,1
18	14,7	10,3	68	55,7	39,0	118	96,6	67,7	168	137,6	96,3	218	178,5	125,0	268	219,5	153,7
19	15,6	10,9	69	56,5	39,6	119	97,5	68,2	169	138,4	96,9	219	179,4	125,6	269	220,3	154,3
20	16,4	11,5	70	57,3	40,1	120	98,3	68,8	170	139,2	97,5	220	180,2	126,2	270	221,1	154,8
21	17,2	12,0	71	58,1	40,7	121	99,1	69,4	171	140,0	98,1	221	181,0	126,7	271	221,9	155,4
22	18,0	12,6	72	59,0	41,3	122	99,9	70,0	172	140,9	98,6	222	181,8	127,3	272	222,8	156,0
23	18,8	13,2	73	59,8	41,9	123	100,7	70,5	173	141,7	99,2	223	182,6	127,9	273	223,6	156,6
24	19,6	13,8	74	60,6	42,4	124	101,6	71,1	174	142,5	99,8	224	183,5	128,5	274	224,4	157,1
25	20,5	14,3	75	61,4	43,0	125	102,4	71,7	175	143,3	100,4	225	184,3	129,0	275	225,2	157,7
26	21,3	14,9	76	62,2	43,6	126	103,2	72,3	176	144,1	100,9	226	185,1	129,6	276	226,0	158,3
27	22,1	15,5	77	63,1	44,2	127	104,0	72,8	177	145,0	101,5	227	185,9	130,2	277	226,9	158,9
28	22,9	16,1	78	63,9	44,7	128	104,8	73,4	178	145,8	102,1	228	186,7	130,8	278	227,7	159,4
29	23,8	16,6	79	64,7	45,3	129	105,6	74,0	179	146,6	102,7	229	187,5	131,3	279	228,5	160,0
30	24,6	17,2	80	65,5	45,9	130	106,5	74,6	180	147,4	103,2	230	188,4	131,9	280	229,3	160,6
31	25,4	17,8	81	66,3	46,5	131	107,3	75,1	181	148,2	103,8	231	189,2	132,5	281	230,1	161,2
32	26,2	18,4	82	67,2	47,0	132	108,1	75,7	182	149,1	104,4	232	190,0	133,1	282	231,0	161,7
33	27,0	18,9	83	68,0	47,6	133	108,9	76,3	183	149,9	105,0	233	190,8	133,6	283	231,8	162,3
34	27,8	19,5	84	68,8	48,2	134	109,7	76,8	184	150,7	105,5	234	191,6	134,2	284	232,6	162,9
35	28,7	20,1	85	69,6	48,7	135	110,6	77,4	185	151,5	106,1	235	192,5	134,8	285	233,4	163,4
36	29,5	20,6	86	70,4	49,3	136	111,4	78,0	186	152,3	106,7	236	193,3	135,3	286	234,2	164,0
37	30,3	21,2	87	71,3	49,9	137	112,2	78,6	187	153,1	107,2	237	194,1	135,9	287	235,0	164,6
38	31,1	21,8	88	72,1	50,5	138	113,0	79,1	188	154,0	107,8	238	194,9	136,5	288	235,9	165,2
39	31,9	22,4	89	72,9	51,0	139	113,8	79,7	189	154,8	108,4	239	195,7	137,1	289	236,7	165,7
40	32,8	22,9	90	73,7	51,6	140	114,6	80,3	190	155,6	109,0	240	196,6	137,6	290	237,5	166,3
41	33,6	23,5	91	74,5	52,2	141	115,5	80,9	191	156,4	109,5	241	197,4	138,2	291	238,3	166,9
42	34,4	24,1	92	75,3	52,8	142	116,3	81,4	192	157,2	110,1	242	198,2	138,8	292	239,1	167,5
43	35,2	24,7	93	76,2	53,3	143	117,1	82,0	193	158,1	110,7	243	199,0	139,4	293	240,0	168,0
44	36,0	25,2	94	77,0	53,9	144	117,9	82,6	194	158,9	111,3	244	199,8	139,9	294	240,8	168,6
45	36,9	25,8	95	77,8	54,5	145	118,8	83,2	195	159,7	111,8	245	200,6	140,5	295	241,6	169,2
46	37,7	26,4	96	78,6	55,1	146	119,6	83,7	196	160,5	112,4	246	201,5	141,1	296	242,4	169,8
47	38,5	27,0	97	79,4	55,6	147	120,4	84,3	197	161,3	113,0	247	202,3	141,7	297	243,2	170,3
48	39,3	27,5	98	80,3	56,2	148	121,2	84,9	198	162,2	113,6	248	203,1	142,2	298	244,1	170,9
49	40,1	28,1	99	81,1	56,8	149	122,0	85,5	199	163,0	114,1	249	203,9	142,8	299	244,9	171,5
50	41,0	28,7	100	81,9	57,4	150	122,8	86,0	200	163,8	114,7	250	204,7	143,4	300	245,7	172,1
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Dep.

Difference of Lat. and Dep. for 55 Deg.

36°. Difference of Latitude and Departure for 36 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,8	00,6	51	41,3	30,0	101	81,7	59,4	151	122,2	88,8	201	162,6	118,1	251	203,1	147,5
2	01,6	01,2	52	42,1	30,6	102	82,5	00,0	152	123,0	89,3	202	163,4	118,7	252	203,9	148,1
3	02,4	01,8	53	42,9	31,2	103	83,3	00,5	153	123,8	89,9	203	164,2	119,3	253	204,7	148,7
4	03,2	02,4	54	43,7	31,7	104	84,1	01,1	154	124,6	90,5	204	165,0	119,9	254	205,5	149,3
5	04,0	02,9	55	44,5	32,3	105	84,9	01,7	155	125,4	91,1	205	165,8	120,5	255	206,3	149,9
6	04,9	03,5	56	45,3	32,9	106	85,8	02,3	156	126,2	91,7	206	166,7	121,1	256	207,1	150,5
7	05,7	04,1	57	46,1	33,5	107	86,6	02,9	157	127,0	92,3	207	167,5	121,7	257	207,9	151,1
8	06,5	04,7	58	46,9	34,1	108	87,4	03,5	158	127,8	92,9	208	168,3	122,3	258	208,7	151,7
9	07,3	05,3	59	47,7	34,7	109	88,2	04,1	159	128,6	93,5	209	169,1	122,8	259	209,5	152,2
10	08,1	05,9	60	48,5	35,3	110	89,0	04,7	160	129,4	94,0	210	169,9	123,4	260	210,3	152,8
11	08,9	06,5	61	49,3	35,9	111	89,8	05,2	161	130,2	94,6	211	170,7	124,0	261	211,1	153,4
12	09,7	07,1	62	50,2	36,4	112	90,6	05,8	162	131,1	95,2	212	171,5	124,6	262	212,0	154,0
13	10,5	07,6	63	51,0	37,0	113	91,4	06,4	163	131,9	95,8	213	172,3	125,2	263	212,8	154,6
14	11,3	08,2	64	51,8	37,6	114	92,2	07,0	164	132,7	96,4	214	173,1	125,8	264	213,6	155,2
15	12,1	08,8	65	52,6	38,2	115	93,0	07,6	165	133,5	97,0	215	173,9	126,4	265	214,4	155,8
16	12,9	09,4	66	53,4	38,8	116	93,8	08,2	166	134,3	97,6	216	174,7	127,0	266	215,2	156,4
17	13,8	10,0	67	54,2	39,4	117	94,7	08,8	167	135,1	98,2	217	175,6	127,6	267	216,0	156,9
18	14,6	10,6	68	55,0	40,0	118	95,5	09,4	168	135,9	98,7	218	176,4	128,1	268	216,8	157,5
19	15,4	11,2	69	55,8	40,6	119	96,3	09,9	169	136,7	99,3	219	177,2	128,7	269	217,6	158,1
20	16,2	11,8	70	56,6	41,1	120	97,1	10,5	170	137,5	99,9	220	178,0	129,3	270	218,4	158,7
21	17,0	12,3	71	57,4	41,7	121	97,9	11,1	171	138,3	100,5	221	178,8	129,9	271	219,2	159,3
22	17,8	12,9	72	58,2	42,3	122	98,7	11,7	172	139,1	101,1	222	179,6	130,5	272	220,0	159,9
23	18,6	13,5	73	59,1	42,9	123	99,5	12,3	173	140,0	101,7	223	180,4	131,1	273	220,9	160,5
24	19,4	14,1	74	59,9	43,5	124	100,3	12,9	174	140,8	102,3	224	181,2	131,7	274	221,7	161,1
25	20,2	14,7	75	60,7	44,1	125	101,1	13,5	175	141,6	102,9	225	182,0	132,3	275	222,5	161,6
26	21,0	15,3	76	61,5	44,7	126	101,9	14,1	176	142,4	103,5	226	182,8	132,8	276	223,3	162,2
27	21,8	15,9	77	62,3	45,3	127	102,7	14,7	177	143,2	104,0	227	183,6	133,4	277	224,1	162,8
28	22,7	16,5	78	63,1	45,8	128	103,6	15,2	178	144,0	104,6	228	184,5	134,0	278	224,9	163,4
29	23,5	17,0	79	63,9	46,4	129	104,4	15,8	179	144,8	105,2	229	185,3	134,6	279	225,7	164,0
30	24,3	17,6	80	64,7	47,0	130	105,2	16,4	180	145,6	105,8	230	186,1	135,2	280	226,5	164,6
31	25,1	18,2	81	65,5	47,6	131	106,0	17,0	181	146,4	106,4	231	186,9	135,8	281	227,3	165,2
32	25,9	18,8	82	66,3	48,2	132	106,8	17,6	182	147,2	107,0	232	187,7	136,4	282	228,1	165,8
33	26,7	19,4	83	67,1	48,8	133	107,6	18,2	183	148,0	107,6	233	188,5	137,0	283	228,9	166,3
34	27,5	20,0	84	68,0	49,4	134	108,4	18,8	184	148,9	108,2	234	189,3	137,5	284	229,8	166,9
35	28,3	20,6	85	68,8	50,0	135	109,2	19,4	185	149,7	108,7	235	190,1	138,1	285	230,6	167,5
36	29,1	21,2	86	69,6	50,6	136	110,0	19,9	186	150,5	109,3	236	190,9	138,7	286	231,4	168,1
37	29,9	21,7	87	70,4	51,1	137	110,8	20,5	187	151,3	109,9	237	191,7	139,3	287	232,2	168,7
38	30,7	22,3	88	71,2	51,7	138	111,6	21,1	188	152,1	110,5	238	192,5	139,9	288	233,0	169,3
39	31,6	22,9	89	72,0	52,3	139	112,5	21,7	189	152,9	111,1	239	193,3	140,5	289	233,8	169,9
40	32,4	23,5	90	72,8	52,9	140	113,3	22,3	190	153,7	111,7	240	194,2	141,1	290	234,6	170,5
41	33,2	24,1	91	73,6	53,5	141	114,1	22,9	191	154,5	112,3	241	195,0	141,7	291	235,4	171,0
42	34,0	24,7	92	74,4	54,1	142	114,9	23,5	192	155,3	112,9	242	195,8	142,2	292	236,2	171,6
43	34,8	25,3	93	75,2	54,7	143	115,7	24,1	193	156,1	113,4	243	196,6	142,8	293	237,0	172,2
44	35,6	25,9	94	76,0	55,3	144	116,5	24,6	194	156,9	114,0	244	197,4	143,4	294	237,8	172,8
45	36,4	26,5	95	76,9	55,8	145	117,3	25,2	195	157,8	114,6	245	198,2	144,0	295	238,7	173,4
46	37,2	27,0	96	77,7	56,4	146	118,1	25,8	196	158,6	115,2	246	199,0	144,6	296	239,5	174,0
47	38,0	27,6	97	78,5	57,0	147	118,9	26,4	197	159,4	115,8	247	199,8	145,2	297	240,3	174,6
48	38,8	28,2	98	79,3	57,6	148	119,7	27,0	198	160,2	116,4	248	200,6	145,8	298	241,1	175,2
49	39,6	28,8	99	80,1	58,2	149	120,5	27,6	199	161,0	117,0	249	201,4	146,4	299	241,9	175,7
50	40,5	29,4	100	80,9	58,8	150	121,3	28,2	200	161,8	117,6	250	202,2	146,9	300	242,7	176,3
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 54 Deg.

37°. Difference of Latitude and Departure for 37 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,8	00,6	51	40,7	30,7	101	80,7	60,8	151	120,6	90,9	201	160,5	121,0	251	200,4	151,0
2	01,6	01,2	52	41,5	31,3	102	81,5	61,4	152	121,4	91,5	202	161,3	121,6	252	201,2	151,6
3	02,4	01,8	53	42,3	31,9	103	82,2	62,0	153	122,2	92,1	203	162,1	122,2	253	202,0	152,2
4	03,2	02,4	54	43,1	32,5	104	83,1	62,6	154	123,0	92,7	204	162,9	122,8	254	202,8	152,9
5	04,0	03,0	55	43,9	33,1	105	83,9	63,2	155	123,8	93,3	205	163,7	123,4	255	203,6	153,5
6	04,8	03,6	56	44,7	33,7	106	84,7	63,8	156	124,6	93,9	206	164,5	124,0	256	204,4	154,1
7	05,6	04,2	57	45,5	34,3	107	85,5	64,4	157	125,4	94,5	207	165,3	124,6	257	205,2	154,7
8	06,4	04,8	58	46,3	34,9	108	86,2	65,0	158	126,2	95,1	208	166,1	125,2	258	206,0	155,3
9	07,2	05,4	59	47,1	35,5	109	87,0	65,6	159	127,0	95,7	209	166,9	125,8	259	206,8	155,9
10	08,0	06,0	60	47,9	36,1	110	87,8	66,2	160	127,8	96,3	210	167,7	126,4	260	207,6	156,5
11	08,8	06,6	61	48,7	36,7	111	88,6	66,8	161	128,6	96,9	211	168,5	127,0	261	208,4	157,1
12	09,6	07,2	62	49,5	37,3	112	89,4	67,4	162	129,4	97,5	212	169,3	127,6	262	209,2	157,7
13	10,4	07,8	63	50,3	37,9	113	90,2	68,0	163	130,2	98,1	213	170,1	128,2	263	210,0	158,3
14	11,2	08,4	64	51,1	38,5	114	91,0	68,6	164	131,0	98,7	214	170,9	128,8	264	210,8	158,9
15	12,0	09,0	65	51,9	39,1	115	91,8	69,2	165	131,8	99,3	215	171,7	129,4	265	211,6	159,5
16	12,8	09,6	66	52,7	39,7	116	92,6	69,8	166	132,6	99,9	216	172,5	130,0	266	212,4	160,1
17	13,6	10,2	67	53,5	40,3	117	93,4	70,4	167	133,4	100,5	217	173,3	130,6	267	213,2	160,7
18	14,4	10,8	68	54,3	40,9	118	94,2	71,0	168	134,2	101,1	218	174,1	131,2	268	214,0	161,3
19	15,2	11,4	69	55,1	41,5	119	95,0	71,6	169	135,0	101,7	219	174,9	131,8	269	214,8	161,9
20	16,0	12,0	70	55,9	42,1	120	95,8	72,2	170	135,8	102,3	220	175,7	132,4	270	215,6	162,5
21	16,8	12,6	71	56,7	42,7	121	96,6	72,8	171	136,6	102,9	221	176,5	133,0	271	216,4	163,1
22	17,6	13,2	72	57,5	43,3	122	97,4	73,4	172	137,4	103,5	222	177,3	133,6	272	217,2	163,7
23	18,4	13,8	73	58,3	43,9	123	98,2	74,0	173	138,2	104,1	223	178,1	134,2	273	218,0	164,3
24	19,2	14,4	74	59,1	44,5	124	99,0	74,6	174	139,0	104,7	224	178,9	134,8	274	218,8	164,9
25	20,0	15,0	75	59,9	45,1	125	99,8	75,2	175	139,8	105,3	225	179,7	135,4	275	219,6	165,5
26	20,8	15,6	76	60,7	45,7	126	100,6	75,8	176	140,6	105,9	226	180,5	136,0	276	220,4	166,1
27	21,6	16,2	77	61,5	46,3	127	101,4	76,4	177	141,4	106,5	227	181,3	136,6	277	221,2	166,7
28	22,4	16,9	78	62,3	46,9	128	102,2	77,0	178	142,2	107,1	228	182,1	137,2	278	222,0	167,3
29	23,2	17,5	79	63,1	47,5	129	103,0	77,6	179	142,9	107,7	229	182,9	137,8	279	222,8	167,9
30	24,0	18,1	80	63,9	48,1	130	103,8	78,2	180	143,7	108,3	230	183,7	138,4	280	223,6	168,5
31	24,8	18,7	81	64,7	48,7	131	104,6	78,8	181	144,5	108,9	231	184,5	139,0	281	224,4	169,1
32	25,6	19,3	82	65,5	49,3	132	105,4	79,4	182	145,3	109,5	232	185,3	139,6	282	225,2	169,7
33	26,4	19,9	83	66,3	49,9	133	106,2	80,0	183	146,1	110,1	233	186,1	140,2	283	226,0	170,3
34	27,2	20,5	84	67,1	50,6	134	107,0	80,6	184	146,9	110,7	234	186,9	140,8	284	226,8	170,9
35	28,0	21,1	85	67,9	51,2	135	107,8	81,2	185	147,7	111,3	235	187,7	141,4	285	227,6	171,5
36	28,7	21,7	86	68,7	51,8	136	108,6	81,8	186	148,5	111,9	236	188,5	142,0	286	228,4	172,1
37	29,5	22,3	87	69,5	52,4	137	109,4	82,4	187	149,3	112,5	237	189,3	142,6	287	229,2	172,7
38	30,3	22,9	88	70,3	53,0	138	110,2	83,0	188	150,1	113,1	238	190,1	143,2	288	230,0	173,3
39	31,1	23,5	89	71,1	53,6	139	111,0	83,6	189	150,9	113,7	239	190,9	143,8	289	230,8	173,9
40	31,9	24,1	90	71,9	54,2	140	111,8	84,2	190	151,7	114,3	240	191,7	144,4	290	231,6	174,5
41	32,7	24,7	91	72,7	54,8	141	112,6	84,9	191	152,5	114,9	241	192,5	145,0	291	232,4	175,1
42	33,5	25,3	92	73,5	55,4	142	113,4	85,5	192	153,3	115,5	242	193,3	145,6	292	233,2	175,7
43	34,3	25,9	93	74,3	56,0	143	114,2	86,1	193	154,1	116,1	243	194,1	146,2	293	234,0	176,3
44	35,1	26,5	94	75,1	56,6	144	115,0	86,7	194	154,9	116,7	244	194,9	146,8	294	234,8	176,9
45	35,9	27,1	95	75,9	57,2	145	115,8	87,3	195	155,7	117,3	245	195,7	147,4	295	235,6	177,5
46	36,7	27,7	96	76,7	57,8	146	116,6	87,9	196	156,5	117,9	246	196,5	148,0	296	236,4	178,1
47	37,5	28,3	97	77,5	58,4	147	117,4	88,5	197	157,3	118,6	247	197,3	148,6	297	237,2	178,7
48	38,3	28,9	98	78,3	59,0	148	118,2	89,1	198	158,1	119,2	248	198,1	149,2	298	238,0	179,3
49	39,1	29,5	99	79,1	59,6	149	119,0	89,7	199	158,9	119,8	249	198,9	149,8	299	238,8	179,9
50	39,9	30,1	100	79,9	60,2	150	119,8	90,3	200	159,7	120,4	250	199,7	150,4	300	239,6	180,5
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 53 Deg.

38°. Difference of Latitude and Departure for 38 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,8	00,6	51	40,2	31,4	101	79,6	62,2	151	119,0	93,0	201	158,4	123,8	251	197,8	154,5
2	01,6	01,2	52	41,0	32,0	102	80,4	62,8	152	119,8	93,6	202	159,2	124,4	252	198,5	155,2
3	02,4	01,8	53	41,8	32,6	103	81,2	63,4	153	120,5	94,2	203	159,9	125,0	253	199,3	155,8
4	03,2	02,5	54	42,5	33,2	104	81,9	64,0	154	121,3	94,8	204	160,7	125,6	254	200,1	156,4
5	04,0	03,1	55	43,3	33,9	105	82,7	64,6	155	122,1	95,4	205	161,5	126,2	255	200,9	157,0
6	04,7	03,7	56	44,1	34,5	106	83,5	65,3	156	122,9	96,0	206	162,3	126,8	256	201,7	157,6
7	05,5	04,3	57	44,9	35,1	107	84,3	65,9	157	123,7	96,7	207	163,1	127,4	257	202,5	158,2
8	06,3	04,9	58	45,7	35,7	108	85,1	66,5	158	124,5	97,3	208	163,9	128,1	258	203,3	158,9
9	07,1	05,5	59	46,5	36,3	109	85,9	67,1	159	125,3	97,9	209	164,7	128,7	259	204,1	159,5
10	07,9	06,2	60	47,3	36,9	110	86,7	67,7	160	126,1	98,5	210	165,5	129,3	260	204,9	160,1
11	08,7	06,8	61	48,1	37,6	111	87,5	68,3	161	126,9	99,1	211	166,2	129,9	261	205,6	160,7
12	09,5	07,4	62	48,9	38,2	112	88,2	69,0	162	127,6	99,7	212	167,0	130,5	262	206,4	161,3
13	10,2	08,0	63	49,6	38,8	113	89,0	69,6	163	128,4	100,4	213	167,8	131,1	263	207,2	161,9
14	11,0	08,6	64	50,4	39,4	114	89,8	70,2	164	129,2	101,0	214	168,6	131,8	264	208,0	162,5
15	11,8	09,2	65	51,2	40,0	115	90,6	70,8	165	130,0	101,6	215	169,4	132,4	265	208,8	163,2
16	12,6	09,9	66	52,0	40,6	116	91,4	71,4	166	130,8	102,2	216	170,2	133,0	266	209,6	163,8
17	13,4	10,5	67	52,8	41,3	117	92,2	72,0	167	131,6	102,8	217	171,0	133,6	267	210,4	164,4
18	14,2	11,1	68	53,6	41,9	118	93,0	72,7	168	132,4	103,4	218	171,8	134,2	268	211,2	165,0
19	15,0	11,7	69	54,4	42,5	119	93,8	73,3	169	133,2	104,1	219	172,5	134,8	269	211,9	165,6
20	15,8	12,3	70	55,2	43,1	120	94,5	73,9	170	133,9	104,7	220	173,3	135,5	270	212,7	166,2
21	16,5	12,9	71	55,9	43,7	121	95,3	74,5	171	134,7	105,3	221	174,1	136,1	271	213,5	166,9
22	17,3	13,5	72	56,7	44,3	122	96,1	75,1	172	135,5	105,9	222	174,9	136,7	272	214,3	167,5
23	18,1	14,2	73	57,5	44,9	123	96,9	75,7	173	136,3	106,5	223	175,7	137,3	273	215,1	168,1
24	19,9	14,8	74	58,3	45,6	124	97,7	76,3	174	137,1	107,1	224	176,5	137,9	274	215,9	168,7
25	19,7	15,4	75	59,1	46,2	125	98,5	76,9	175	137,9	107,7	225	177,3	138,5	275	216,7	169,3
26	20,5	16,0	76	59,9	46,8	126	99,3	77,6	176	138,7	108,4	226	178,1	139,1	276	217,5	169,9
27	21,3	16,6	77	60,7	47,4	127	100,1	78,2	177	139,5	109,0	227	178,9	139,8	277	218,2	170,5
28	22,1	17,2	78	61,5	48,0	128	100,9	78,8	178	140,2	109,6	228	179,6	140,4	278	219,0	171,2
29	22,9	17,9	79	62,2	48,6	129	101,6	79,4	179	141,0	110,2	229	180,4	141,0	279	219,8	171,8
30	23,6	18,5	80	63,0	49,3	130	102,4	80,0	180	141,8	110,8	230	181,2	141,6	280	220,6	172,4
31	24,4	19,1	81	63,8	49,9	131	103,2	80,7	181	142,6	111,4	231	182,0	142,2	281	221,4	173,0
32	25,2	19,7	82	64,6	50,5	132	104,0	81,3	182	143,4	112,1	232	182,8	142,8	282	222,2	173,6
33	26,0	20,3	83	65,4	51,1	133	104,8	81,9	183	144,2	112,7	233	183,6	143,5	283	223,0	174,2
34	26,8	20,9	84	66,2	51,7	134	105,6	82,5	184	145,0	113,3	234	184,4	144,1	284	223,8	174,9
35	27,6	21,5	85	67,0	52,3	135	106,4	83,1	185	145,8	113,9	235	185,2	144,7	285	224,5	175,5
36	28,4	22,2	86	67,8	53,0	136	107,2	83,7	186	146,5	114,5	236	185,9	145,3	286	225,3	176,1
37	29,2	22,8	87	68,5	53,6	137	107,9	84,4	187	147,3	115,1	237	186,7	145,9	287	226,1	176,7
38	29,9	23,4	88	69,3	54,2	138	108,7	85,0	188	148,1	115,8	238	187,5	146,5	288	226,9	177,3
39	30,7	24,0	89	70,1	54,8	139	109,5	85,6	189	148,9	116,4	239	188,3	147,2	289	227,7	177,9
40	31,5	24,6	90	70,9	55,4	140	110,3	86,2	190	149,7	117,0	240	189,1	147,8	290	228,5	178,6
41	32,3	25,2	91	71,7	56,0	141	111,1	86,8	191	150,5	117,6	241	189,9	148,4	291	229,3	179,2
42	33,1	25,9	92	72,5	56,6	142	111,9	87,4	192	151,3	118,2	242	190,7	149,0	292	230,1	179,8
43	33,9	26,5	93	73,3	57,3	143	112,7	88,0	193	152,1	118,8	243	191,5	149,6	293	230,9	180,4
44	34,7	27,1	94	74,1	57,9	144	113,5	88,7	194	152,9	119,4	244	192,2	150,2	294	231,6	181,0
45	35,5	27,7	95	74,9	58,5	145	114,2	89,3	195	153,6	120,1	245	193,0	150,8	295	232,4	181,6
46	36,2	28,3	96	75,6	59,1	146	115,0	89,9	196	154,4	120,7	246	193,8	151,5	296	233,2	182,2
47	37,0	28,9	97	76,4	59,7	147	115,8	90,5	197	155,2	121,3	247	194,6	152,1	297	234,0	182,9
48	37,8	29,6	98	77,2	60,3	148	116,6	91,1	198	156,0	121,9	248	195,4	152,7	298	234,8	183,5
49	38,6	30,2	99	78,0	61,0	149	117,4	91,7	199	156,8	122,5	249	196,2	153,3	299	235,6	184,1
50	39,4	30,8	100	78,8	61,6	150	118,2	92,4	200	157,6	123,1	250	197,0	153,9	300	236,4	184,7
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 52 Deg.

39°. Difference of Latitude and Departure for 39 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,8	00,6	51	39,6	32,1	101	78,5	63,6	151	117,3	95,0	201	156,2	126,5	251	195,1	158,0
2	01,6	01,3	52	40,4	32,7	102	79,3	64,2	152	118,1	95,7	202	157,0	127,1	252	195,8	158,6
3	02,3	01,9	53	41,2	33,4	103	80,0	64,8	153	118,9	96,3	203	157,8	127,7	253	196,6	159,2
4	03,1	02,5	54	42,0	34,0	104	80,8	65,4	154	119,7	96,9	204	158,5	128,4	254	197,4	159,8
5	03,9	03,1	55	42,7	34,6	105	81,6	66,1	155	120,5	97,5	205	159,3	129,0	255	198,2	160,5
6	04,7	03,8	56	43,5	35,2	106	82,4	66,7	156	121,2	98,2	206	160,1	129,6	256	198,9	161,1
7	05,4	04,4	57	44,3	35,9	107	83,0	67,3	157	122,0	98,8	207	160,9	130,3	257	199,7	161,7
8	06,2	05,0	58	45,1	36,5	108	83,9	68,0	158	122,8	99,4	208	161,6	130,9	258	200,5	162,4
9	07,0	05,7	59	45,8	37,1	109	84,7	68,6	159	123,6	100,1	209	162,4	131,5	259	201,3	163,0
10	07,8	06,3	60	46,6	37,8	110	85,5	69,2	160	124,3	100,7	210	163,2	132,2	260	202,0	163,6
11	08,5	06,9	61	47,4	38,4	111	86,3	69,9	161	125,1	101,3	211	164,0	132,8	261	202,8	164,2
12	09,3	07,6	62	48,2	39,0	112	87,0	70,5	162	125,9	101,9	212	164,7	133,4	262	203,6	164,9
13	10,1	08,2	63	49,0	39,6	113	87,8	71,1	163	126,7	102,6	213	165,5	134,0	263	204,4	165,5
14	10,9	08,8	64	49,7	40,3	114	88,6	71,7	164	127,4	103,2	214	166,3	134,7	264	205,2	166,1
15	11,7	09,4	65	50,5	40,9	115	89,1	72,4	165	128,2	103,8	215	167,1	135,3	265	205,9	166,8
16	12,4	10,1	66	51,3	41,5	116	90,1	73,0	166	129,0	104,5	216	167,9	135,9	266	206,7	167,4
17	13,2	10,7	67	52,1	42,2	117	90,9	73,6	167	129,8	105,1	217	168,6	136,6	267	207,5	168,0
18	14,0	11,3	68	52,8	42,8	118	91,7	74,3	168	130,6	105,7	218	169,4	137,2	268	208,3	168,7
19	14,8	12,0	69	53,6	43,4	119	92,5	74,9	169	131,3	106,4	219	170,2	137,8	269	209,0	169,3
20	15,5	12,6	70	54,4	44,1	120	93,3	75,5	170	132,1	107,0	220	171,0	138,4	270	209,8	169,9
21	16,3	13,2	71	55,2	44,7	121	94,0	76,1	171	132,9	107,6	221	171,7	139,1	271	210,6	170,5
22	17,1	13,8	72	56,0	45,3	122	94,8	76,8	172	133,7	108,2	222	172,5	139,7	272	211,4	171,2
23	17,9	14,5	73	56,7	45,9	123	95,6	77,4	173	134,4	108,9	223	173,3	140,3	273	212,1	171,8
24	18,7	15,1	74	57,5	46,6	124	96,4	78,0	174	135,2	109,5	224	174,1	141,0	274	212,9	172,4
25	19,4	15,7	75	58,3	47,2	125	97,1	78,7	175	136,0	110,1	225	174,8	141,6	275	213,7	173,1
26	20,2	16,4	76	59,1	47,8	126	97,9	79,3	176	136,8	110,8	226	175,6	142,2	276	214,5	173,7
27	21,0	17,0	77	59,8	48,5	127	98,7	79,9	177	137,5	111,4	227	176,4	142,9	277	215,3	174,3
28	21,8	17,6	78	60,6	49,1	128	99,5	80,6	178	138,3	112,0	228	177,2	143,5	278	216,0	174,9
29	22,5	18,2	79	61,4	49,7	129	100,2	81,2	179	139,1	112,6	229	178,0	144,1	279	216,8	175,6
30	23,3	18,9	80	62,2	50,3	130	101,0	81,8	180	139,9	113,3	230	178,7	144,7	280	217,6	176,2
31	24,1	19,5	81	62,9	51,0	131	101,8	82,4	181	140,7	113,9	231	179,5	145,4	281	218,4	176,8
32	24,9	20,1	82	63,7	51,6	132	102,6	83,1	182	141,4	114,5	232	180,3	146,0	282	219,1	177,5
33	25,6	20,8	83	64,5	52,2	133	103,4	83,7	183	142,2	115,2	233	181,1	146,6	283	219,9	178,1
34	26,4	21,4	84	65,3	52,9	134	104,1	84,3	184	143,0	115,8	234	181,8	147,3	284	220,7	178,7
35	27,2	22,0	85	66,1	53,5	135	104,9	85,0	185	143,8	116,4	235	182,6	147,9	285	221,5	179,4
36	28,0	22,7	86	66,8	54,1	136	105,7	85,6	186	144,5	117,1	236	183,4	148,5	286	222,3	180,0
37	28,8	23,3	87	67,6	54,7	137	106,5	86,2	187	145,3	117,7	237	184,2	149,1	287	223,0	180,6
38	29,5	23,9	88	68,4	55,4	138	107,2	86,8	188	146,1	118,3	238	185,0	149,8	288	223,8	181,2
39	30,3	24,5	89	69,2	56,0	139	108,0	87,5	189	146,9	118,9	239	185,7	150,4	289	224,6	181,9
40	31,1	25,2	90	69,9	56,6	140	108,8	88,1	190	147,6	119,6	240	186,5	151,0	290	225,4	182,5
41	31,9	25,8	91	70,7	57,3	141	109,6	88,7	191	148,4	120,2	241	187,3	151,7	291	226,1	183,1
42	32,6	26,4	92	71,5	57,9	142	110,3	89,4	192	149,2	120,8	242	188,1	152,3	292	226,9	183,8
43	33,4	27,1	93	72,3	58,5	143	111,1	90,0	193	150,0	121,5	243	188,8	152,9	293	227,7	184,4
44	34,2	27,7	94	73,0	59,2	144	111,9	90,6	194	150,8	122,1	244	189,6	153,6	294	228,5	185,0
45	35,0	28,3	95	73,8	59,8	145	112,7	91,2	195	151,5	122,7	245	190,4	154,2	295	229,2	185,6
46	35,7	28,9	96	74,6	60,4	146	113,5	91,9	196	152,3	123,3	246	191,2	154,8	296	230,0	186,3
47	36,5	29,6	97	75,4	61,0	147	114,2	92,5	197	153,1	124,0	247	191,9	155,4	297	230,8	186,9
48	37,3	30,2	98	76,2	61,7	148	115,0	93,1	198	153,9	124,6	248	192,7	156,1	298	231,6	187,5
49	38,1	30,8	99	76,9	62,3	149	115,8	93,8	199	154,6	125,2	249	193,5	156,7	299	232,4	188,2
50	38,9	31,5	100	77,7	62,9	150	116,6	94,4	200	155,4	125,9	250	194,3	157,3	300	233,1	188,8
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 51 Deg.

40°. Difference of Latitude and Departure for 40 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	D. p.	Diff.	Lat.	D. p.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,8	00,6	51	39,1	32,8	101	77,4	64,9	151	115,7	97,1	201	154,0	129,2	251	192,3	161,4
2	01,5	01,3	52	39,8	33,4	102	78,1	65,6	152	116,4	97,7	202	154,7	129,9	252	193,0	162,0
3	02,3	01,9	53	40,6	34,1	103	78,9	66,2	153	117,2	98,4	203	155,5	130,5	253	193,8	162,6
4	03,1	02,6	54	41,4	34,7	104	79,7	66,8	154	118,0	99,0	204	156,3	131,1	254	194,5	163,3
5	03,8	03,2	55	42,1	35,3	105	80,4	67,5	155	118,7	99,6	205	157,0	131,8	255	195,3	163,9
6	04,6	03,9	56	42,9	36,0	106	81,2	68,1	156	119,5	100,3	206	157,8	132,4	256	196,1	164,6
7	05,4	04,5	57	43,7	36,6	107	82,0	68,8	157	120,3	100,9	207	158,6	133,1	257	196,9	165,2
8	06,1	05,1	58	44,4	37,3	108	82,7	69,4	158	121,0	101,6	208	159,3	133,7	258	197,6	165,9
9	06,9	05,8	59	45,2	37,9	109	83,5	70,1	159	121,8	102,2	209	160,1	134,4	259	198,4	166,5
10	07,7	06,4	60	46,0	38,6	110	84,3	70,7	160	122,6	102,8	210	160,9	135,0	260	199,2	167,1
11	08,4	07,1	61	46,7	39,2	111	85,0	71,3	161	123,3	103,5	211	161,6	135,6	261	199,9	167,8
12	09,2	07,7	62	47,5	39,9	112	85,8	72,0	162	124,1	104,1	212	162,4	136,3	262	200,7	168,4
13	10,0	08,4	63	48,3	40,5	113	86,6	72,6	163	124,9	104,8	213	163,2	136,9	263	201,4	169,1
14	10,7	09,0	64	49,0	41,1	114	87,3	73,3	164	125,6	105,4	214	163,9	137,6	264	202,2	169,7
15	11,5	09,6	65	49,8	41,8	115	88,1	73,9	165	126,4	106,1	215	164,7	138,2	265	203,0	170,4
16	12,3	10,3	66	50,6	42,4	116	88,9	74,6	166	127,2	106,7	216	165,4	138,8	266	203,7	171,0
17	13,0	10,9	67	51,3	43,1	117	89,6	75,2	167	127,9	107,3	217	166,2	139,5	267	204,5	171,6
18	13,8	11,6	68	52,1	43,7	118	90,4	75,9	168	128,7	108,0	218	167,0	140,1	268	205,3	172,3
19	14,6	12,2	69	52,9	44,4	119	91,2	76,5	169	129,4	108,6	219	167,7	140,8	269	206,0	172,9
20	15,3	12,9	70	53,6	45,0	120	91,9	77,1	170	130,2	109,3	220	168,5	141,4	270	206,8	173,6
21	16,1	13,5	71	54,4	45,6	121	92,7	77,8	171	131,0	109,9	221	169,3	142,1	271	207,6	174,2
22	16,9	14,1	72	55,2	46,3	122	93,4	78,4	172	131,7	110,6	222	170,0	142,7	272	208,3	174,8
23	17,6	14,8	73	55,9	46,9	123	94,2	79,1	173	132,5	111,2	223	170,8	143,3	273	209,1	175,5
24	18,4	15,4	74	56,7	47,6	124	95,0	79,7	174	133,3	111,9	224	171,6	144,0	274	209,9	176,1
25	19,2	16,1	75	57,4	48,2	125	95,7	80,4	175	134,0	112,5	225	172,3	144,6	275	210,6	176,8
26	19,9	16,7	76	58,2	48,9	126	96,5	81,0	176	134,8	113,1	226	173,1	145,3	276	211,4	177,4
27	20,7	17,4	77	59,0	49,5	127	97,3	81,6	177	135,6	113,8	227	173,9	145,9	277	212,2	178,1
28	21,4	18,0	78	59,7	50,1	128	98,0	82,3	178	136,3	114,4	228	174,6	146,6	278	212,9	178,7
29	22,2	18,6	79	60,5	50,8	129	98,8	82,9	179	137,1	115,1	229	175,4	147,2	279	213,7	179,3
30	23,0	19,3	80	61,3	51,4	130	99,6	83,6	180	137,9	115,7	230	176,2	147,9	280	214,5	180,0
31	23,7	19,9	81	62,0	52,1	131	100,3	84,2	181	138,6	116,4	231	176,9	148,5	281	215,2	180,6
32	24,5	20,6	82	62,8	52,7	132	101,1	84,9	182	139,4	117,0	232	177,7	149,1	282	216,0	181,3
33	25,3	21,2	83	63,6	53,4	133	101,9	85,5	183	140,2	117,6	233	178,5	149,8	283	216,8	181,9
34	26,0	21,9	84	64,3	54,0	134	102,6	86,1	184	140,9	118,3	234	179,2	150,4	284	217,5	182,6
35	26,8	22,5	85	65,1	54,6	135	103,4	86,8	185	141,7	118,9	235	180,0	151,1	285	218,3	183,2
36	27,6	23,1	86	65,9	55,3	136	104,2	87,4	186	142,5	119,6	236	180,8	151,7	286	219,1	183,9
37	28,3	23,8	87	66,6	55,9	137	104,9	88,1	187	143,2	120,2	237	181,5	152,4	287	219,8	184,5
38	29,1	24,4	88	67,4	56,6	138	105,7	88,7	188	144,0	120,9	238	182,3	153,0	288	220,6	185,1
39	29,9	25,1	89	68,2	57,2	139	106,5	89,4	189	144,8	121,5	239	183,1	153,6	289	221,4	185,8
40	30,6	25,7	90	68,9	57,9	140	107,2	90,0	190	145,5	122,1	240	183,8	154,3	290	222,1	186,4
41	31,4	26,4	91	69,7	58,5	141	108,0	90,6	191	146,3	122,8	241	184,6	154,9	291	222,9	187,1
42	32,2	27,0	92	70,5	59,1	142	108,8	91,3	192	147,1	123,4	242	185,4	155,6	292	223,7	187,7
43	32,9	27,6	93	71,2	59,8	143	109,5	91,9	193	147,8	124,1	243	186,1	156,2	293	224,4	188,4
44	33,7	28,3	94	72,0	60,4	144	110,3	92,6	194	148,6	124,7	244	186,9	156,9	294	225,2	189,0
45	34,5	28,9	95	72,8	61,1	145	111,1	93,2	195	149,4	125,4	245	187,7	157,5	295	226,0	189,6
46	35,2	29,6	96	73,5	61,7	146	111,8	93,9	196	150,1	126,0	246	188,4	158,1	296	226,7	190,3
47	36,0	30,2	97	74,3	62,4	147	112,6	94,5	197	150,9	126,6	247	189,2	158,8	297	227,5	190,9
48	36,8	30,8	98	75,1	63,0	148	113,4	95,1	198	151,7	127,3	248	190,0	159,4	298	228,3	191,6
49	37,5	31,5	99	75,8	63,6	149	114,1	95,8	199	152,4	127,9	249	190,7	160,1	299	229,0	192,2
50	38,3	32,1	100	76,6	64,3	150	114,9	96,4	200	153,2	128,6	250	191,5	160,7	300	229,8	192,9
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 50 Deg.

41°. Difference of Latitude and Departure for 41 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,8	00,7	51	38,5	33,5	101	76,2	66,3	151	114,0	99,0	201	151,7	131,8	251	189,4	164,6
2	01,5	01,3	52	39,2	34,1	102	77,0	66,9	152	114,7	99,7	202	152,5	132,5	252	190,2	165,3
3	02,3	02,0	53	40,0	34,8	103	77,7	67,6	153	115,5	100,4	203	153,2	133,2	253	190,9	166,0
4	03,0	02,6	54	40,8	35,4	104	78,5	68,2	154	116,2	101,0	204	154,0	133,8	254	191,7	166,6
5	03,8	03,3	55	41,5	36,1	105	79,2	68,9	155	117,0	101,7	205	154,7	134,5	255	192,5	167,3
6	04,5	03,9	56	42,3	36,7	106	80,0	69,5	156	117,7	102,3	206	155,5	135,1	256	193,2	167,9
7	05,3	04,6	57	43,0	37,4	107	80,8	70,2	157	118,5	103,0	207	156,2	135,8	257	194,0	168,6
8	06,0	05,2	58	43,8	38,0	108	81,5	70,8	158	119,2	103,6	208	157,0	136,4	258	194,7	169,2
9	06,8	05,9	59	44,5	38,7	109	82,3	71,5	159	120,0	104,3	209	157,7	137,1	259	195,5	169,9
10	07,5	06,6	60	45,3	39,4	110	83,0	72,2	160	120,8	105,0	210	158,5	137,7	260	196,2	170,5
11	08,3	07,2	61	46,0	40,0	111	83,8	72,8	161	121,5	105,6	211	159,2	138,4	261	197,0	171,2
12	09,1	07,9	62	46,8	40,7	112	84,5	73,5	162	122,3	106,3	212	160,0	139,1	262	197,7	171,9
13	09,8	08,5	63	47,5	41,3	113	85,3	74,1	163	123,0	106,9	213	160,8	139,7	263	198,5	172,5
14	10,6	09,2	64	48,3	42,0	114	86,0	74,8	164	123,8	107,6	214	161,5	140,4	264	199,2	173,2
15	11,3	09,8	65	49,1	42,6	115	86,8	75,4	165	124,5	108,2	215	162,3	141,0	265	200,0	173,8
16	12,1	10,5	66	49,8	43,3	116	87,5	76,1	166	125,3	108,9	216	163,0	141,7	266	200,8	174,5
17	12,8	11,2	67	50,6	44,0	117	88,3	76,7	167	126,0	109,5	217	163,8	142,3	267	201,5	175,1
18	13,6	11,8	68	51,3	44,6	118	89,1	77,4	168	126,8	110,2	218	164,5	143,0	268	202,3	175,8
19	14,3	12,5	69	52,1	45,3	119	89,8	78,1	169	127,5	110,9	219	165,3	143,6	269	203,0	176,4
20	15,1	13,1	70	52,8	45,9	120	90,6	78,7	170	128,3	111,5	220	166,0	144,3	270	203,8	177,1
21	15,8	13,8	71	53,6	46,6	121	91,3	79,4	171	129,1	112,2	221	166,8	145,0	271	204,5	177,8
22	16,6	14,4	72	54,3	47,2	122	92,1	80,0	172	129,8	112,8	222	167,5	145,6	272	205,3	178,4
23	17,4	15,1	73	55,1	47,9	123	92,8	80,7	173	130,6	113,5	223	168,3	146,3	273	206,0	179,1
24	18,1	15,7	74	55,8	48,5	124	93,6	81,3	174	131,3	114,1	224	169,1	146,9	274	206,8	179,7
25	18,9	16,4	75	56,6	49,2	125	94,3	82,0	175	132,1	114,8	225	169,8	147,6	275	207,5	180,4
26	19,6	17,1	76	57,4	49,9	126	95,1	82,6	176	132,8	115,4	226	170,6	148,2	276	208,3	181,0
27	20,4	17,7	77	58,1	50,5	127	95,8	83,3	177	133,6	116,1	227	171,3	148,9	277	209,1	181,7
28	21,1	18,4	78	58,9	51,2	128	96,6	84,0	178	134,3	116,8	228	172,1	149,6	278	209,8	182,4
29	21,9	19,0	79	59,6	51,8	129	97,4	84,6	179	135,1	117,4	229	172,8	150,2	279	210,6	183,0
30	22,6	19,7	80	60,4	52,5	130	98,1	85,3	180	135,8	118,1	230	173,6	150,9	280	211,3	183,7
31	23,4	20,3	81	61,1	53,1	131	98,8	85,9	181	136,6	118,7	231	174,3	151,5	281	212,1	184,3
32	24,2	21,0	82	61,9	53,8	132	99,6	86,6	182	137,4	119,4	232	175,1	152,2	282	212,8	185,0
33	24,9	21,6	83	62,6	54,4	133	100,4	87,2	183	138,1	120,0	233	175,8	152,8	283	213,6	185,6
34	25,7	22,3	84	63,4	55,1	134	101,1	87,9	184	138,9	120,7	234	176,6	153,5	284	214,3	186,3
35	26,4	23,0	85	64,2	55,8	135	101,9	88,6	185	139,6	121,4	235	177,4	154,1	285	215,1	186,9
36	27,2	23,6	86	64,9	56,4	136	102,6	89,2	186	140,4	122,0	236	178,1	154,8	286	215,8	187,6
37	27,9	24,3	87	65,7	57,1	137	103,4	89,9	187	141,1	122,7	237	178,9	155,5	287	216,6	188,3
38	28,7	24,9	88	66,4	57,7	138	104,2	90,5	188	141,9	123,3	238	179,6	156,1	288	217,4	188,9
39	29,4	25,6	89	67,2	58,4	139	104,9	91,2	189	142,6	124,0	239	180,4	156,8	289	218,1	189,6
40	30,2	26,2	90	67,9	59,0	140	105,7	91,8	190	143,4	124,6	240	181,1	157,4	290	218,9	190,2
41	30,9	26,9	91	68,7	59,7	141	106,4	92,5	191	144,2	125,3	241	181,9	158,1	291	219,6	190,9
42	31,7	27,6	92	69,4	60,4	142	107,2	93,1	192	144,9	125,9	242	182,6	158,7	292	220,4	191,5
43	32,5	28,2	93	70,2	61,0	143	107,9	93,8	193	145,7	126,6	243	183,4	159,4	293	221,1	192,2
44	33,2	28,9	94	70,9	61,7	144	108,7	94,5	194	146,4	127,3	244	184,2	160,0	294	221,9	192,8
45	34,0	29,5	95	71,7	62,3	145	109,4	95,1	195	147,2	127,9	245	184,9	160,7	295	222,6	193,5
46	34,7	30,2	96	72,5	63,0	146	110,2	95,8	196	147,9	128,6	246	185,7	161,4	296	223,4	194,2
47	35,5	30,8	97	73,2	63,6	147	110,9	96,4	197	148,7	129,2	247	186,4	162,0	297	224,2	194,8
48	36,2	31,5	98	74,0	64,3	148	111,7	97,1	198	149,4	129,9	248	187,2	162,7	298	224,9	195,5
49	37,0	32,1	99	74,7	64,9	149	112,5	97,7	199	150,2	130,5	249	187,9	163,3	299	225,7	196,1
50	37,7	32,8	100	75,5	65,6	150	113,2	98,4	200	150,0	131,2	250	188,7	164,0	300	226,4	196,8
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 49 Deg.

42°. Difference of Latitude and Departure for 42 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,7	00,7	51	37,9	34,1	101	75,0	67,6	151	112,2	101,0	201	149,3	134,5	251	186,5	167,9
2	01,5	01,3	52	38,6	34,8	102	75,8	68,2	152	112,9	101,7	202	150,1	135,1	252	187,2	168,6
3	02,2	02,0	53	39,4	35,5	103	76,5	68,9	153	113,7	102,4	203	150,8	135,8	253	187,9	169,3
4	03,0	02,7	54	40,1	36,1	104	77,3	69,6	154	114,4	103,0	204	151,5	136,5	254	188,7	169,9
5	03,7	03,3	55	40,9	36,8	105	78,0	70,2	155	115,1	103,7	205	152,3	137,1	255	189,4	170,6
6	04,5	04,0	56	41,6	37,5	106	78,7	70,9	156	115,9	104,4	206	153,0	137,8	256	190,2	171,3
7	05,2	04,7	57	42,3	38,1	107	79,5	71,6	157	116,6	105,0	207	153,8	138,5	257	190,9	171,9
8	05,9	05,4	58	43,1	38,8	108	80,2	72,3	158	117,4	105,7	208	154,5	139,1	258	191,7	172,6
9	06,7	06,0	59	43,8	39,5	109	81,0	72,9	159	118,1	106,4	209	155,3	139,8	259	192,4	173,3
10	07,4	06,7	60	44,6	40,1	110	81,7	73,6	160	118,9	107,0	210	156,0	140,5	260	193,1	173,9
11	08,2	07,4	61	45,3	40,8	111	82,5	74,3	161	119,6	107,7	211	156,7	141,2	261	193,9	174,6
12	08,9	08,0	62	46,1	41,5	112	83,2	74,9	162	120,3	108,4	212	157,5	141,8	262	194,6	175,3
13	09,7	08,7	63	46,8	42,1	113	83,9	75,6	163	121,1	109,0	213	158,2	142,5	263	195,4	175,9
14	10,4	09,4	64	47,5	42,8	114	84,7	76,3	164	121,8	109,7	214	159,0	143,2	264	196,1	176,6
15	11,1	10,0	65	48,3	43,5	115	85,4	76,9	165	122,6	110,4	215	159,7	143,8	265	196,9	177,3
16	11,9	10,7	66	49,0	44,2	116	86,2	77,6	166	123,3	111,0	216	160,5	144,5	266	197,6	177,9
17	12,6	11,4	67	49,8	44,8	117	86,9	78,3	167	124,1	111,7	217	161,2	145,2	267	198,4	178,6
18	13,4	12,0	68	50,5	45,5	118	87,7	78,9	168	124,8	112,4	218	161,9	145,8	268	199,1	179,3
19	14,1	12,7	69	51,3	46,2	119	88,4	79,6	169	125,5	113,1	219	162,7	146,5	269	199,8	180,0
20	14,9	13,4	70	52,0	46,8	120	89,1	80,3	170	126,3	113,7	220	163,4	147,2	270	200,6	180,6
21	15,6	14,0	71	52,7	47,5	121	89,9	80,9	171	127,0	114,4	221	164,2	147,8	271	201,3	181,3
22	16,3	14,7	72	53,5	48,2	122	90,6	81,6	172	127,8	115,1	222	164,9	148,5	272	202,1	182,0
23	17,1	15,4	73	54,2	48,8	123	91,4	82,3	173	128,5	115,7	223	165,7	149,2	273	202,8	182,6
24	17,8	16,1	74	55,0	49,5	124	92,1	83,0	174	129,3	116,4	224	166,4	149,9	274	203,5	183,3
25	18,6	16,7	75	55,7	50,2	125	92,9	83,6	175	130,0	117,1	225	167,1	150,5	275	204,3	184,0
26	19,3	17,4	76	56,5	50,8	126	93,6	84,3	176	130,7	117,7	226	167,9	151,2	276	205,0	184,6
27	20,1	18,1	77	57,2	51,5	127	94,3	85,0	177	131,5	118,4	227	168,6	151,9	277	205,8	185,3
28	20,8	18,7	78	57,9	52,2	128	95,1	85,6	178	132,2	119,1	228	169,4	152,5	278	206,5	186,0
29	21,5	19,4	79	58,7	52,9	129	95,8	86,3	179	133,0	119,7	229	170,1	153,2	279	207,3	186,6
30	22,3	20,1	80	59,4	53,5	130	96,6	87,0	180	133,7	120,4	230	170,9	153,9	280	208,0	187,3
31	23,0	20,7	81	60,2	54,2	131	97,3	87,6	181	134,5	121,1	231	171,6	154,5	281	208,7	188,0
32	23,8	21,4	82	60,9	54,9	132	98,1	88,3	182	135,2	121,8	232	172,3	155,2	282	209,5	188,7
33	24,5	22,1	83	61,7	55,5	133	98,8	89,0	183	135,9	122,4	233	173,1	155,9	283	210,2	189,3
34	25,3	22,7	84	62,4	56,2	134	99,5	89,6	184	136,7	123,1	234	173,8	156,5	284	211,0	190,0
35	26,0	23,4	85	63,1	56,9	135	100,3	90,3	185	137,4	123,8	235	174,6	157,2	285	211,7	190,7
36	26,7	24,1	86	63,9	57,5	136	101,0	91,0	186	138,2	124,4	236	175,3	157,9	286	212,5	191,3
37	27,5	24,8	87	64,6	58,2	137	101,8	91,7	187	138,9	125,1	237	176,1	158,5	287	213,2	192,0
38	28,2	25,4	88	65,4	58,9	138	102,5	92,3	188	139,7	125,8	238	176,8	159,2	288	213,9	192,7
39	29,0	26,1	89	66,1	59,5	139	103,3	93,0	189	140,4	126,4	239	177,5	159,9	289	214,7	193,3
40	29,7	26,8	90	66,9	60,2	140	104,0	93,7	190	141,1	127,1	240	178,3	160,6	290	215,4	194,0
41	30,5	27,4	91	67,6	60,9	141	104,7	94,3	191	141,9	127,8	241	179,0	161,2	291	216,2	194,7
42	31,2	28,1	92	68,3	61,5	142	105,5	95,0	192	142,6	128,4	242	179,8	161,9	292	216,9	195,3
43	31,9	28,8	93	69,1	62,2	143	106,2	95,7	193	143,4	129,1	243	180,5	162,6	293	217,7	196,0
44	32,7	29,4	94	69,8	62,9	144	107,0	96,3	194	144,1	129,8	244	181,3	163,2	294	218,4	196,7
45	33,4	30,1	95	70,6	63,6	145	107,7	97,0	195	144,9	130,5	245	182,0	163,9	295	219,1	197,4
46	34,2	30,8	96	71,3	64,2	146	108,5	97,7	196	145,6	131,1	246	182,7	164,6	296	219,9	198,0
47	34,9	31,4	97	72,1	64,9	147	109,2	98,3	197	146,3	131,8	247	183,5	165,1	297	220,6	198,7
48	35,7	32,1	98	72,8	65,6	148	109,9	99,0	198	147,1	132,5	248	184,2	165,9	298	221,4	199,4
49	36,4	32,8	99	73,5	66,2	149	110,7	99,7	199	147,8	133,1	249	185,0	166,6	299	222,1	200,0
50	37,1	33,5	100	74,3	66,9	150	111,4	100,4	200	148,6	133,8	250	185,7	167,3	300	222,9	200,7
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 48 Deg.

43°. Difference of Latitude and Departure for 43 Deg.

Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
07,9	1	00,7	00,7	51	37,3	34,8	101	73,9	68,9	151	110,4	103,0	201	147,0	137,1	251	183,6	171,2
08,6	2	01,5	01,4	52	38,0	35,5	102	74,6	69,5	152	111,2	103,6	202	147,7	137,7	252	184,3	171,8
09,3	3	02,2	02,0	53	38,8	36,2	103	75,3	70,2	153	111,9	104,3	203	148,5	138,4	253	185,0	172,5
09,9	4	02,9	02,7	54	39,5	36,8	104	76,1	70,9	154	112,6	105,0	204	149,2	139,1	254	185,8	173,2
10,6	5	03,7	03,4	55	40,2	37,5	105	76,8	71,6	155	113,4	105,7	205	149,9	139,8	255	186,5	173,9
11,3	6	04,4	04,1	56	41,0	38,2	106	77,5	72,3	156	114,1	106,4	206	150,7	140,5	256	187,2	174,5
11,9	7	05,1	04,8	57	41,7	38,9	107	78,3	73,0	157	114,8	107,1	207	151,4	141,2	257	187,9	175,2
12,6	8	05,9	05,5	58	42,4	39,5	108	79,0	73,6	158	115,6	107,7	208	152,1	141,8	258	188,7	175,9
13,3	9	06,6	06,2	59	43,1	40,2	109	79,7	74,3	159	116,3	108,4	209	152,9	142,5	259	189,4	176,6
13,9	10	07,3	06,8	60	43,9	40,9	110	80,4	75,0	160	117,0	109,1	210	153,6	143,2	260	190,1	177,3
14,6	11	08,0	07,5	61	44,6	41,6	111	81,2	75,7	161	117,7	109,8	211	154,3	143,9	261	190,9	178,0
15,3	12	08,8	08,2	62	45,3	42,3	112	81,9	76,4	162	118,5	110,5	212	155,0	144,5	262	191,6	178,6
15,9	13	09,5	08,9	63	46,1	43,0	113	82,6	77,1	163	119,2	111,2	213	155,8	145,2	263	192,3	179,3
16,6	14	10,2	09,5	64	46,8	43,6	114	83,4	77,7	164	119,9	111,8	214	156,5	145,9	264	193,1	180,0
17,3	15	11,0	10,2	65	47,5	44,3	115	84,1	78,4	165	120,7	112,5	215	157,2	146,6	265	193,8	180,7
17,9	16	11,7	10,9	66	48,3	45,0	116	84,8	79,1	166	121,4	113,2	216	158,0	147,3	266	194,5	181,4
18,6	17	12,4	11,6	67	49,0	45,7	117	85,6	79,8	167	122,1	113,9	217	158,7	148,0	267	195,3	182,1
19,3	18	13,2	12,3	68	49,7	46,4	118	86,3	80,5	168	122,9	114,5	218	159,4	148,6	268	196,0	182,7
19,9	19	13,9	13,0	69	50,5	47,1	119	87,0	81,2	169	123,6	115,2	219	160,2	149,3	269	196,7	183,4
20,6	20	14,6	13,6	70	51,2	47,7	120	87,8	81,8	170	124,3	115,9	220	160,9	150,0	270	197,5	184,1
21,3	21	15,4	14,3	71	51,9	48,4	121	88,5	82,5	171	125,1	116,6	221	161,6	150,7	271	198,2	184,8
22,0	22	16,1	15,0	72	52,7	49,1	122	89,2	83,2	172	125,8	117,3	222	162,4	151,4	272	198,9	185,5
22,6	23	16,8	15,7	73	53,4	49,8	123	90,0	83,9	173	126,5	118,0	223	163,1	152,1	273	199,7	186,2
23,3	24	17,6	16,4	74	54,1	50,5	124	90,7	84,5	174	127,3	118,6	224	163,8	152,7	274	200,4	186,8
24,0	25	18,3	17,1	75	54,9	51,2	125	91,4	85,2	175	128,0	119,3	225	164,6	153,4	275	201,1	187,5
24,6	26	19,0	17,7	76	55,6	51,8	126	92,1	85,9	176	128,7	120,0	226	165,3	154,1	276	201,9	188,2
25,3	27	19,7	18,4	77	56,3	52,5	127	92,9	86,6	177	129,4	120,7	227	166,0	154,8	277	202,6	188,9
26,0	28	20,5	19,1	78	57,0	53,2	128	93,6	87,3	178	130,2	121,4	228	166,7	155,5	278	203,3	189,5
26,6	29	21,2	19,8	79	57,8	53,9	129	94,3	88,0	179	130,9	122,1	229	167,5	156,2	279	204,0	190,2
27,3	30	21,9	20,5	80	58,5	54,5	130	95,1	88,6	180	131,6	122,7	230	168,2	156,8	280	204,8	190,9
28,0	31	22,7	21,2	81	59,2	55,2	131	95,8	89,3	181	132,4	123,4	231	168,9	157,5	281	205,5	191,6
28,7	32	23,4	21,8	82	60,0	55,9	132	96,5	90,0	182	133,1	124,1	232	169,7	158,2	282	206,2	192,3
29,3	33	24,1	22,5	83	60,7	56,6	133	97,3	90,7	183	133,8	124,8	233	170,4	158,9	283	207,0	193,0
29,9	34	24,9	23,2	84	61,4	57,3	134	98,0	91,4	184	134,6	125,5	234	171,1	159,5	284	207,7	193,6
30,6	35	25,6	23,9	85	62,2	58,0	135	98,7	92,1	185	135,3	126,2	235	171,9	160,2	285	208,4	194,3
31,3	36	26,3	24,5	86	62,9	58,6	136	99,5	92,7	186	136,0	126,8	236	172,6	160,9	286	209,2	195,0
32,0	37	27,1	25,2	87	63,6	59,3	137	100,2	93,4	187	136,8	127,5	237	173,3	161,6	287	209,9	195,7
32,7	38	27,8	25,9	88	64,4	60,0	138	100,9	94,1	188	137,5	128,2	238	174,1	162,3	288	210,6	196,4
33,3	39	28,5	26,6	89	65,1	60,7	139	101,7	94,8	189	138,2	128,9	239	174,8	163,0	289	211,4	197,1
34,0	40	29,3	27,3	90	65,8	61,4	140	102,4	95,5	190	139,0	129,5	240	175,5	163,6	290	212,1	197,7
34,7	41	30,0	28,0	91	66,6	62,1	141	103,1	96,2	191	139,7	130,2	241	176,3	164,3	291	212,8	198,4
35,3	42	30,7	28,6	92	67,3	62,7	142	103,9	96,8	192	140,4	130,9	242	177,0	165,0	292	213,6	199,1
36,0	43	31,4	29,3	93	68,0	63,4	143	104,6	97,5	193	141,1	131,6	243	177,7	165,7	293	214,3	199,8
36,7	44	32,2	30,0	94	68,7	64,1	144	105,3	98,2	194	141,9	132,3	244	178,4	166,4	294	215,0	200,5
37,4	45	32,9	30,7	95	69,5	64,8	145	106,0	98,9	195	142,6	133,0	245	179,2	167,1	295	215,7	201,2
38,0	46	33,6	31,4	96	70,2	65,5	146	106,8	99,5	196	143,3	133,6	246	179,9	167,7	296	216,5	201,8
38,7	47	34,4	32,1	97	70,9	66,2	147	107,5	100,2	197	144,1	134,3	247	180,6	168,4	297	217,2	202,5
39,4	48	35,1	32,7	98	71,7	66,8	148	108,2	100,9	198	144,8	135,0	248	181,4	169,1	298	218,0	203,2
40,0	49	35,8	33,4	99	72,4	67,5	149	109,0	101,6	199	145,5	135,7	249	182,1	169,8	299	218,7	203,9
40,7	50	36,6	34,1	100	73,1	68,2	150	109,7	102,3	200	146,3	136,4	250	182,8	170,5	300	219,4	204,6
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.

Difference of Lat. and Dep. for 47 Deg.

44°. Difference of Latitude and Departure for 44 Deg.

Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.	Diff.	Lat.	Dep.
1	00,7	00,7	51	36,7	35,4	101	72,6	70,2	151	108,6	104,9	201	144,6	139,2	251	180,5	174,3
2	01,4	01,4	52	37,4	36,1	102	73,4	70,8	152	109,3	105,6	202	145,3	140,3	252	181,3	175,0
3	02,1	02,1	53	38,1	36,8	103	74,1	71,5	153	110,1	106,3	203	146,0	141,0	253	182,0	175,7
4	02,9	02,8	54	38,8	37,5	104	74,8	72,2	154	110,8	107,0	204	146,7	141,7	254	182,7	176,4
5	03,6	03,5	55	39,6	38,2	105	75,5	72,9	155	111,5	107,7	205	147,5	142,4	255	183,4	177,1
6	04,3	04,2	56	40,3	38,9	106	76,2	73,6	156	112,2	108,4	206	148,2	143,1	256	184,1	177,8
7	05,0	04,9	57	41,0	39,6	107	77,0	74,3	157	112,9	109,1	207	148,9	143,8	257	184,9	178,5
8	05,8	05,6	58	41,7	40,3	108	77,7	75,0	158	113,6	109,7	208	149,6	144,5	258	185,6	179,2
9	06,5	06,3	59	42,4	41,0	109	78,4	75,7	159	114,4	110,4	209	150,3	145,2	259	186,3	179,9
10	07,2	06,9	60	43,2	41,7	110	79,1	76,4	160	115,1	111,1	210	151,1	145,9	260	187,0	180,6
11	07,9	07,6	61	43,9	42,4	111	79,8	77,1	161	115,8	111,8	211	151,8	146,6	261	187,7	181,3
12	08,6	08,3	62	44,6	43,1	112	80,6	77,8	162	116,5	112,5	212	152,5	147,3	262	188,5	182,0
13	09,4	09,0	63	45,3	43,8	113	81,3	78,5	163	117,2	113,2	213	153,2	147,9	263	189,2	182,7
14	10,1	09,7	64	46,0	44,5	114	82,0	79,2	164	118,0	113,9	214	153,9	148,6	264	189,9	183,4
15	10,8	10,4	65	46,8	45,1	115	82,7	79,9	165	118,7	114,6	215	154,6	149,3	265	190,6	184,1
16	11,5	11,1	66	47,5	45,8	116	83,4	80,6	166	119,4	115,3	216	155,4	150,0	266	191,3	184,8
17	12,2	11,8	67	48,2	46,5	117	84,2	81,3	167	120,1	116,0	217	156,1	150,7	267	192,1	185,5
18	12,9	12,5	68	48,9	47,2	118	84,9	82,0	168	120,8	116,7	218	156,8	151,4	268	192,8	186,1
19	13,7	13,2	69	49,6	47,9	119	85,6	82,7	169	121,6	117,4	219	157,5	152,1	269	193,5	186,8
20	14,4	13,9	70	50,4	48,6	120	86,3	83,4	170	122,3	118,1	220	158,2	152,8	270	194,2	187,5
21	15,1	14,6	71	51,1	49,3	121	87,0	84,0	171	123,0	118,8	221	159,0	153,5	271	194,9	188,2
22	15,8	15,3	72	51,8	50,0	122	87,8	84,7	172	123,7	119,5	222	159,7	154,2	272	195,6	188,9
23	16,5	16,0	73	52,5	50,7	123	88,5	85,4	173	124,4	120,2	223	160,4	154,9	273	196,4	189,6
24	17,3	16,7	74	53,2	51,4	124	89,2	86,1	174	125,2	120,9	224	161,1	155,6	274	197,1	190,3
25	18,0	17,4	75	53,9	52,1	125	89,9	86,8	175	125,9	121,6	225	161,8	156,3	275	197,8	191,0
26	18,7	18,1	76	54,7	52,8	126	90,6	87,5	176	126,6	122,2	226	162,6	157,0	276	198,5	191,7
27	19,4	18,8	77	55,4	53,5	127	91,4	88,2	177	127,3	122,9	227	163,3	157,7	277	199,2	192,4
28	20,1	19,4	78	56,1	54,2	128	92,1	88,9	178	128,0	123,6	228	164,0	158,4	278	200,0	193,1
29	20,9	20,1	79	56,8	54,9	129	92,8	89,6	179	128,8	124,3	229	164,7	159,1	279	200,7	193,8
30	21,6	20,8	80	57,5	55,6	130	93,5	90,3	180	129,5	125,0	230	165,4	159,8	280	201,4	194,5
31	22,3	21,5	81	58,3	56,3	131	94,2	91,0	181	130,2	125,7	231	166,2	160,4	281	202,1	195,2
32	23,0	22,2	82	59,0	57,0	132	94,9	91,7	182	130,9	126,4	232	166,9	161,1	282	202,8	195,9
33	23,7	22,9	83	59,7	57,7	133	95,7	92,4	183	131,6	127,1	233	167,6	161,8	283	203,6	196,6
34	24,5	23,6	84	60,4	58,3	134	96,4	93,1	184	132,4	127,8	234	168,3	162,5	284	204,3	197,3
35	25,2	24,3	85	61,1	59,0	135	97,1	93,8	185	133,1	128,5	235	169,0	163,2	285	205,0	198,0
36	25,9	25,0	86	61,9	59,7	136	97,8	94,5	186	133,8	129,2	236	169,8	163,9	286	205,7	198,7
37	26,6	25,7	87	62,6	60,4	137	98,5	95,2	187	134,5	129,9	237	170,5	164,6	287	206,4	199,3
38	27,3	26,4	88	63,3	61,1	138	99,3	95,9	188	135,2	130,6	238	171,2	165,3	288	207,2	200,0
39	28,1	27,1	89	64,0	61,8	139	100,0	96,5	189	135,9	131,3	239	171,9	166,0	289	207,9	200,7
40	28,8	27,8	90	64,7	62,5	140	100,7	97,2	190	136,7	132,0	240	172,6	166,7	290	208,6	201,4
41	29,5	28,5	91	65,5	63,2	141	101,4	97,9	191	137,4	132,7	241	173,4	167,4	291	209,3	202,1
42	30,2	29,2	92	66,2	63,9	142	102,1	98,6	192	138,1	133,4	242	174,1	168,1	292	210,0	202,8
43	30,9	29,9	93	66,9	64,6	143	102,9	99,3	193	138,8	134,1	243	174,8	168,8	293	210,8	203,5
44	31,6	30,6	94	67,6	65,3	144	103,6	100,0	194	139,5	134,8	244	175,5	169,5	294	211,5	204,2
45	32,4	31,3	95	68,3	66,0	145	104,3	100,7	195	140,3	135,4	245	176,2	170,2	295	212,2	204,9
46	33,1	32,0	96	69,1	66,7	146	105,0	101,4	196	141,0	136,1	246	176,9	170,9	296	212,9	205,6
47	33,8	32,6	97	69,8	67,4	147	105,7	102,1	197	141,7	136,8	247	177,7	171,6	297	213,6	206,3
48	34,5	33,3	98	70,5	68,1	148	106,5	102,8	198	142,4	137,5	248	178,4	172,3	298	214,4	207,0
49	35,2	34,0	99	71,2	68,8	149	107,2	103,5	199	143,1	138,2	249	179,1	173,0	299	215,1	207,7
50	36,0	34,7	100	71,9	69,5	150	107,9	104,2	200	143,9	138,9	250	179,8	173,6	300	215,8	208,4
Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.	Diff.	Dep.	Lat.

Difference of Lat. and Dep. for 46 Deg.

45°. Difference of Latitude and Departure for 45 Deg.

Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.	Dift.	Lat.	Dep.
1	00,7	00,7	51	36,1	36,1	101	71,4	71,4	151	106,8	106,8	201	142,1	142,1	251	177,5	177,5
2	01,4	01,4	52	36,8	36,8	102	72,1	72,1	152	107,5	107,5	202	142,8	142,8	252	178,2	178,2
3	02,1	02,1	53	37,5	37,5	103	72,8	72,8	153	108,2	108,2	203	143,5	143,5	253	178,9	178,9
4	02,8	02,8	54	38,2	38,2	104	73,5	73,5	154	108,9	108,9	204	144,2	144,2	254	179,6	179,6
5	03,5	03,5	55	38,9	38,9	105	74,2	74,2	155	109,6	109,6	205	144,9	144,9	255	180,3	180,3
6	04,2	04,2	56	39,6	39,6	106	74,9	74,9	156	110,3	110,3	206	145,7	145,7	256	181,0	181,0
7	04,9	04,9	57	40,3	40,3	107	75,7	75,7	157	111,0	111,0	207	146,4	146,4	257	181,7	181,7
8	05,7	05,7	58	41,0	41,0	108	76,4	76,4	158	111,7	111,7	208	147,1	147,1	258	182,4	182,4
9	06,4	06,4	59	41,7	41,7	109	77,1	77,1	159	112,4	112,4	209	147,8	147,8	259	183,1	183,1
10	07,1	07,1	60	42,4	42,4	110	77,8	77,8	160	113,1	113,1	210	148,5	148,5	260	183,8	183,8
11	07,8	07,8	61	43,1	43,1	111	78,5	78,5	161	113,8	113,8	211	149,2	149,2	261	184,5	184,5
12	08,5	08,5	62	43,8	43,8	112	79,2	79,2	162	114,5	114,5	212	149,9	149,9	262	185,3	185,3
13	09,2	09,2	63	44,5	44,5	113	79,9	79,9	163	115,3	115,3	213	150,6	150,6	263	186,0	186,0
14	09,9	09,9	64	45,3	45,3	114	80,6	80,6	164	116,0	116,0	214	151,3	151,3	264	186,7	186,7
15	10,6	10,6	65	46,0	46,0	115	81,3	81,3	165	116,7	116,7	215	152,0	152,0	265	187,4	187,4
16	11,3	11,3	66	46,7	46,7	116	82,0	82,0	166	117,4	117,4	216	152,7	152,7	266	188,1	188,1
17	12,0	12,0	67	47,4	47,4	117	82,7	82,7	167	118,1	118,1	217	153,4	153,4	267	188,8	188,8
18	12,7	12,7	68	48,1	48,1	118	83,4	83,4	168	118,8	118,8	218	154,1	154,1	268	189,5	189,5
19	13,4	13,4	69	48,8	48,8	119	84,1	84,1	169	119,5	119,5	219	154,8	154,8	269	190,2	190,2
20	14,1	14,1	70	49,5	49,5	120	84,8	84,8	170	120,2	120,2	220	155,6	155,6	270	190,9	190,9
21	14,8	14,8	71	50,2	50,2	121	85,6	85,6	171	120,9	120,9	221	156,3	156,3	271	191,6	191,6
22	15,6	15,6	72	50,9	50,9	122	86,3	86,3	172	121,6	121,6	222	157,0	157,0	272	192,3	192,3
23	16,3	16,3	73	51,6	51,6	123	87,0	87,0	173	122,3	122,3	223	157,7	157,7	273	193,0	193,0
24	17,0	17,0	74	52,3	52,3	124	87,7	87,7	174	123,0	123,0	224	158,4	158,4	274	193,7	193,7
25	17,7	17,7	75	53,0	53,0	125	88,4	88,4	175	123,7	123,7	225	159,1	159,1	275	194,4	194,4
26	18,4	18,4	76	53,7	53,7	126	89,1	89,1	176	124,4	124,4	226	159,8	159,8	276	195,2	195,2
27	19,1	19,1	77	54,4	54,4	127	89,8	89,8	177	125,2	125,2	227	160,5	160,5	277	195,9	195,9
28	19,8	19,8	78	55,2	55,2	128	90,5	90,5	178	125,9	125,9	228	161,2	161,2	278	196,6	196,6
29	20,5	20,5	79	55,9	55,9	129	91,2	91,2	179	126,6	126,6	229	161,9	161,9	279	197,3	197,3
30	21,2	21,2	80	56,6	56,6	130	91,9	91,9	180	127,3	127,3	230	162,6	162,6	280	198,0	198,0
31	21,9	21,9	81	57,3	57,3	131	92,6	92,6	181	128,0	128,0	231	163,3	163,3	281	198,7	198,7
32	22,6	22,6	82	58,0	58,0	132	93,3	93,3	182	128,7	128,7	232	164,0	164,0	282	199,4	199,4
33	23,3	23,3	83	58,7	58,7	133	94,0	94,0	183	129,4	129,4	233	164,7	164,7	283	200,1	200,1
34	24,0	24,0	84	59,4	59,4	134	94,7	94,7	184	130,1	130,1	234	165,5	165,5	284	200,8	200,8
35	24,7	24,7	85	60,1	60,1	135	95,5	95,5	185	130,8	130,8	235	166,2	166,2	285	201,5	201,5
36	25,5	25,5	86	60,8	60,8	136	96,2	96,2	186	131,5	131,5	236	166,9	166,9	286	202,2	202,2
37	26,2	26,2	87	61,5	61,5	137	96,9	96,9	187	132,2	132,2	237	167,6	167,6	287	202,9	202,9
38	26,9	26,9	88	62,2	62,2	138	97,6	97,6	188	132,9	132,9	238	168,3	168,3	288	203,6	203,6
39	27,6	27,6	89	62,9	62,9	139	98,3	98,3	189	133,6	133,6	239	169,0	169,0	289	204,3	204,3
40	28,3	28,3	90	63,6	63,6	140	99,0	99,0	190	134,3	134,3	240	169,7	169,7	290	205,1	205,1
41	29,0	29,0	91	64,3	64,3	141	99,7	99,7	191	135,1	135,1	241	170,4	170,4	291	205,8	205,8
42	29,7	29,7	92	65,1	65,1	142	100,4	100,4	192	135,8	135,8	242	171,1	171,1	292	206,5	206,5
43	30,4	30,4	93	65,8	65,8	143	101,1	101,1	193	136,5	136,5	243	171,8	171,8	293	207,2	207,2
44	31,1	31,1	94	66,5	66,5	144	101,8	101,8	194	137,2	137,2	244	172,5	172,5	294	207,9	207,9
45	31,8	31,8	95	67,2	67,2	145	102,5	102,5	195	137,9	137,9	245	173,2	173,2	295	208,6	208,6
46	32,5	32,5	96	67,9	67,9	146	103,2	103,2	196	138,6	138,6	246	173,9	173,9	296	209,3	209,3
47	33,2	33,2	97	68,6	68,6	147	103,9	103,9	197	139,3	139,3	247	174,6	174,6	297	210,0	210,0
48	33,9	33,9	98	69,3	69,3	148	104,6	104,6	198	140,0	140,0	248	175,4	175,4	298	210,7	210,7
49	34,6	34,6	99	70,0	70,0	149	105,4	105,4	199	140,7	140,7	249	176,1	176,1	299	211,4	211,4
50	35,4	35,4	100	70,7	70,7	150	106,1	106,1	200	141,4	141,4	250	176,8	176,8	300	212,1	212,1
Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.	Dift.	Dep.	Lat.

Difference of Lat. and Dep. for 45 Deg.

A T A B L E

Of the ANGLES which every Rumb, or Point, and Quarter Point of the COMPASS, makes with the Meridian.

NORTH & SOUTH		Hours. 12 o'clock	Points	d. m.	NORTH & SOUTH		Hours. 12 o'clock
1.	2.	3.	4.	5.	6.	7.	8.
N.b.E.	S.b.W.	H. $0\frac{3}{4}$	$0\frac{1}{4}$ $0\frac{1}{2}$ $0\frac{3}{4}$ 1	2.48 $\frac{3}{4}$ 5.37 $\frac{1}{2}$ 8.26 $\frac{1}{4}$ 11.15	S.b.E.	N.b.W.	H. 11 $\frac{1}{4}$
N.N.E.	S.S.W.	$1\frac{1}{2}$	$1\frac{1}{4}$ $1\frac{1}{2}$ $1\frac{3}{4}$ 2	14.3 $\frac{3}{4}$ 16.52 $\frac{1}{2}$ 19.41 $\frac{1}{4}$ 22.30	S.S.E.	N.N.W.	10 $\frac{1}{2}$
N.E.b.N.	S.W.b.S.	$2\frac{1}{4}$	$2\frac{1}{4}$ $2\frac{1}{2}$ $2\frac{3}{4}$ 3	25.18 $\frac{3}{4}$ 28.7 $\frac{1}{2}$ 30.56 $\frac{1}{4}$ 33.45	S.E.b.S.	N.W.b.N.	9 $\frac{3}{4}$
N.E.	S.W.	3	$3\frac{1}{4}$ $3\frac{1}{2}$ $3\frac{3}{4}$ 4	36.33 $\frac{3}{4}$ 39.22 $\frac{1}{2}$ 42.11 $\frac{1}{4}$ 45.00	S.E.	N.W.	9
N.E.b.E.	S.W.b.W.	$3\frac{3}{4}$	$4\frac{1}{4}$ $4\frac{1}{2}$ $4\frac{3}{4}$ 5	47.48 $\frac{3}{4}$ 50.37 $\frac{1}{2}$ 53.26 $\frac{1}{4}$ 56.15	S.E.b.E.	N.W.b.W.	8 $\frac{1}{4}$
E.N.E.	W.S.W.	$4\frac{1}{2}$	$5\frac{1}{4}$ $5\frac{1}{2}$ $5\frac{3}{4}$ 6	59.3 $\frac{3}{4}$ 61.52 $\frac{1}{2}$ 64.41 $\frac{1}{4}$ 67.30	E.S.E.	W.N.W.	7 $\frac{1}{2}$
E.b.N.	W.b.S.	$5\frac{1}{4}$	$6\frac{1}{4}$ $6\frac{1}{2}$ $6\frac{3}{4}$ 7	70.18 $\frac{3}{4}$ 73.7 $\frac{1}{2}$ 75.56 $\frac{1}{4}$ 78.45	E.b.S.	W.b.N.	6 $\frac{3}{4}$
E.	W.	6	$7\frac{1}{4}$ $7\frac{1}{2}$ $7\frac{3}{4}$ 8	81.33 $\frac{3}{4}$ 84.22 $\frac{1}{2}$ 87.11 $\frac{1}{4}$ 90.00	E.	W.	6

Note. The time in the 3d column, when adapted to the bearing of the moon, as in the 1st col. is after midnight; but her bearing, as in the 2nd col. is afternoon. Also when the moon bears as denoted in the 6th col. that the time is reckoned from midnight, as in the 8th col. or in hours (A.M.) of the morning; but her bearing, as in the 7th col. to be reckoned in time, in the 8th col. afternoon.

Whence the bearings of the moon, in 1st col. are reckoned in time after midnight in col. 3d.

Do. in the 2d are reckoned in time after mid-day in the 3d.

Do. in the 6th are reckoned in time after midnight in the 8th.

Do. in the 7th are reckoned in time after mid-day in the 8th.

The

The USE of the TRAVERSE TABLES, or Table of the Difference of Lat. and Dep. for each Point and quarter Point of the Compass: Also of the Table to each Degree from the Meridian.

THE first page of the first table contains the difference of latitude and departure for courses made one quarter of a point from the Meridian, towards the East or West; and for distances from 1 to 200 minutes, or geographical miles.

Remark. There are three places of decimals in the diff. of lat. and dep. columns, to the distance of 100; these are done for the purpose of finding the diff. of lat. and dep. corresponding to large distances, or to find the course and distance from the diff. of lat. and dep. being given.

Ex. 1. Suppose a ship sail E.N.E. 987 miles: How many minutes has she differed her latitude, and what departure has she made?

	lat.	dep.
Thus ENE. 900'	334,4	831,5
87	33,3	80,4
The sum 987	367,7	911,9

For against 9 is 3,444 lat. and 8,315 dep. whence by adding two cyphers to the 9, it becomes 900, and the lat. and dep. will then become 334,4, and 831,5; that is, for every cypher added to the distance, you are to make that number of places of the decimals in the

lat. and dep. columns, whole numbers. And in like manner, if the distance given had been 9870; then the diff. of lat. would be 3677, and the dep. 9119.

Ex. 2. Suppose the difference of latitude between two places be 796 miles, and the course N.E. by N. $\frac{1}{4}$ E. What is the distance, and what the departure?

Find the course, and under it in lat. column, I find 796,2, and 653,4 dep. Now the lat. being ,2' more than that given. I look what lat. 1 mile of dist. gives, and find it to be near ,8 of a mile;—therefore I find the dist. is 1027 miles.* Note. We shall in general take the nearest number of whole miles, for distances; as taking parts of a mile, is trifling, and can answer no purpose in the art of navigation.

The table of points and quarters, is to work the courses and distances sailed: And the table of degrees, from 1° to 45° at the top of the table, and from 45° to 90° at the foot, is to find the course and distance made good each day; as also for finding the longitude made, agreeable to the dead reckoning, or account, from day to day; also for a number of days; the whole of which will be fully shewn in the Journal of a Voyage towards the West Indies.

The further USE of the TRAVERSE TABLE.

THIS table is used to find the latitude and departure made by the ship on each different course, by having given the course corrected, and the distance sailed. Also when several courses and distances are given, you may find the latitude and departure made with them, by adding the latitudes of the same name together, and the departures in like manner; but if some of the latitudes, or departures be of different names, then the difference of the latitudes and of the departures will be the difference of latitude and departure made, by sailing that traverse.

Note, That a marine mile, or a minute, is the same with a geographical mile; 60' to 1°.

Ex. 1. A ship sailed from the lat. 50°.10' N; W.S.W. 188 miles: What diff. of latitude and departure has she made?

By the traverse table over W.S.W. and against 188 dist. is 71,95 d. lat. and 173,69 dep. Whence the ship has differed her latitude 72 miles, or 1°.12' S. and she has departed from the meridian 173,7 miles, which may be called 174 miles = 2°.54' W. because when the first place of decimals exceeds ,5, then 1 may generally be taken for it, and added to the figure in the place of units: But if it be less than ,5, it may be cast off.

Note.

* Thus, If 7,7 lat. gives 10 dist. then 2 lat. will give 2,6 dist.
As 10 : 6,3 dep. :: 2,6 dist. : 1,6 dep.
Which subtr. from - - 653,4
True departure - - 651,8 W.

Hence from 1030,0
Take 2,6
True dist. 1027,4

Note. To operate in all respects with departure, as directed in p. 28, for lon. (See Geography.)

The lat. of the place a ship sailed from $50^{\circ}.10' N.$ which is generally called the lat. from.

The lat. made is - - - $1.12 S.$ or diff. of lat.

The lat. the ship is in, is - $48.58 N.$ or lat. in.

Here follow the SIX CASES of PLANE SAILING.

Case 1. The Course and distance given, to find the lat. and dep. made. Suppose a ship sailed W.bN. $\frac{1}{2} W.$ 450 miles: What lat. and dep. has she made? By traverse table over $7\frac{1}{2}$ points, and against

	150	is	14,7	and	149,28
Times	3		$\times 3$		$\times 3$
Dist.	450	lat.	44,1	dep.	447,84

Hence she has differed her lat. 44 miles N.

And she has departed from the meridian 448 miles = $7^{\circ}.28' W.$

Case 2. The course and difference of latitude given, to find the dist. sailed and the dep. made. A ship sailed E.S.E. $\frac{1}{4} E.$ till she differed her lat. $2^{\circ}.25' S.$ What dist. and dep. has she made?

By trav. tab. over the col. $6\frac{1}{4}$ points, and against the diff. of lat. 145 or 14,5 is 40,48 dep. and 43 dist. which numbers multiplied by 10 give the dist. 430 miles, and the dep. 404,8 E. which is nearly true; but a correction may be made as follows.

	Dist.	Dep.	Lat.
	430	404,85	144,87
Correction add	,39	,37	,13
	430,39	405,22	145,00

Note. When the correction applied to make the given number is additive, the others are also additive; but when the correction is deductive, the others are also deductive.

To make the correction. Apply a quantity to the nearest numb. in the table, to make the same as the number given; find that number of correction in its proper column in the table, or the nearest to it, and in the other columns will be the numbers of the correction.

Answer. She has sailed 430,4 miles; and she has departed from the meridian 405 miles E.

Case 3. The course and departure given, to find the distance and difference of latitude. Suppose a ship sail S.E.bS. $\frac{1}{2} E.$ till she make her departure 1° . What distance must she sail, and what difference of latitude make?

	Dep.	Lat.	Dist.
By the table under $3\frac{1}{2}$ points, I find in dep. col.	60,268	73,435	95,
Correction subtract	,268	,325	,42
Gives	60,000	73,110	94,58

Answer. She must sail 94,58 miles, and she will then have differed her lat. $73' S.$

Case 4. The distance and the difference of lat. being given, to find the course and dep. Suppose a ship sailed from Funchal Bay (the S.E. part of Madeira, its lat. $32^{\circ}.34' N.$) 376 miles, and differed her lat. $2^{\circ}.50' S.$ What was her course, and what dep. has she made?

60
or $170' South.$

By table, find $\frac{1}{2}$ the dist. 188, and $\frac{1}{2}$ the diff. of lat. 85, in the proper columns; and you will find the course S. $63^{\circ} E.$ or S. $63^{\circ} W.$ and her departure 335.

Remark. In this case there should have been given, the quarter that the ship sailed in; without which the quarter she sailed in cannot be determined.

Case 5. The distance and dep. given, to find the course and diff. of lat. the ship has made. A ship sailed from the Cape of Good Hope 500 miles, and she departed from the meridian of the said Cape 250 miles West: What course had she sailed, and what difference of lat. had she made?

By

By the table, 50 and 25 being found in their proper columns, give the course S. 30° W. or N. 30° W. and either course made gives the difference of lat. 433 miles: Whence if she failed in the N.W. quarter, her course was N. 30° W. and she has differed her lat. towards the North 433' = 7°.13' N. But if she failed in the S.W. quarter, she has differed her lat. 7°.13' S.

Case 6. The difference of lat. and the dep. being given, To find the course and distance. If a ship sail in the S.E. quarter till she differ her lat. 5°.40' S. and dep. from the meridian of the place sailed from 10°.10' E. What course and distance did she sail?

5°.40' = 340' lat. } Which gives the course S. 61° E. dist. 698 miles.
10°.10' = 610 dep.

To correct BEARINGS taken, or COURSES steered, by a Compass which varies a given Number of degrees, or whose Variation is known.

1. IF the variation be West, reckon that quantity towards the left hand of such course or bearing, and you will have the course corrected.

2. If the variation be East, reckon that quantity towards the right hand of the course steered, or bearing taken, and you will have the course corrected, by variation.

To correct the COURSE by LEE-WAY. See p. 34, def. 7.

3. If the lee-way be made towards the meridian, take it from the course steered, and you will have the course made by the compass: But if the lee-way be made from the meridian, add it to the course, and you will have the course made.

4. Otherwise, When the lee-way and the variation are both to be reckoned the same way, then apply their sum to the course steered; but when they are to be applied contrary ways, then their difference applied to the course steered, will give the course corrected, by lee-way and variation, or course made.

The Courses steered, the Lee-way, and the Variation being given, To find the Courses made, or the true Courses in respect to the Meridian.

Courses steered.	Wind.	Lee-way.	Variation.	Courses correct.
N.W. $\frac{1}{2}$ W.	N.N.E.	$\frac{1}{2}$	$\frac{1}{4}$ W.	N. $5\frac{1}{4}$ W.
W.	N.N.W.	$\frac{1}{2}$	—	S. $6\frac{1}{4}$ W.
W.S.W.	S.	1	—	S. $6\frac{1}{4}$ W.
W.	S.S.W.	$\frac{3}{4}$	—	W.
W.b.N.	N.b.W.	$1\frac{1}{4}$	—	S. 7 W.
S.W.	W.N.W.	$1\frac{1}{2}$	—	S. $1\frac{1}{4}$ W.
S.	W.S.W.	$\frac{3}{4}$	$1\frac{1}{4}$ W.	S.S.E.
S.S.W.	W.	1	—	S. $\frac{1}{4}$ E.
S.W.	N.W.b.W.	$\frac{1}{2}$	—	S.S.W. $\frac{1}{4}$ W.
W.	S.S.W.	$1\frac{1}{4}$	—	W.b.N. $\frac{1}{2}$ W.
W.b.N.	N.b.W.	1	—	W.S.W. $\frac{3}{4}$ W.
S.	E.S.E.	2	—	S. $\frac{1}{4}$ W.
E.b.S.	S. $\frac{1}{2}$ E.	$\frac{3}{4}$	—	E.b.N.
E.N.E.	N.	$1\frac{1}{4}$	—	E.N.E. $\frac{1}{4}$ E.
E.	N.	$\frac{3}{4}$	—	E.b.N. $\frac{1}{2}$ E.
E.	S.S.W.	0	—	E.N.E. $\frac{3}{4}$ E.
S.	E.S.E.	$\frac{1}{4}$	$1\frac{3}{4}$ W.	S.b.E. $\frac{1}{4}$ E.
E.S.E.	N.E.	$\frac{1}{2}$	—	E.b.S. $\frac{1}{4}$ E.
W.S.W.	S.	$\frac{3}{4}$	—	S.W.b.W.
W.b.N.	S.W.b.S.	1	—	W. $\frac{1}{4}$ N.
N.W.	W.S.W.	1	—	N.W. $\frac{3}{4}$ W.
S.	W.S.W.	1	$0\frac{1}{4}$ E.	S. $\frac{3}{4}$ E.
N.b.E.	N.W.b.W.	$\frac{3}{4}$	$\frac{1}{2}$ E.	N.N.E. $\frac{1}{4}$ E.
N.W.b.N.	W.b.S.	$1\frac{1}{4}$	1 E.	N. $\frac{3}{4}$ W.
N.W.b.W.	N.b.E.	$1\frac{1}{2}$	$1\frac{1}{4}$ E.	NWbW $\frac{1}{4}$ W.
W.b.S.	N.W.b.N.	$1\frac{3}{4}$	$2\frac{1}{4}$ E.	W. $\frac{1}{2}$ S.

Remark. When you sail in a channel, or along a coast, in a tide or current, particular care must be taken of it, so as to take its set for a course, and its drift for a distance; which must be entered among the courses and distances in the table of that day's reckoning. And where the setting of the tide and the drift are not known, you must attain the point it must set upon, both of the flood and the ebb, from the charts of the coast you are sailing along, by the times of high water, at different places on the coast, and by the mechanical principles of fluids, acting against such coasts, rocks and shoals, sand banks, &c.—By a strict regard to these, both the set and the drift may be nearly obtained.

1. A current, or tide, is a progressive motion of the water, which causes all floating bodies to move with it.

2. The setting of a tide or current, is that point of the compass towards which it runs.

3. The drift, is the rate it runs at in an hour, and so on from hour to hour.

4. The setting and drift of currents in general, are pretty well known; but where they are not known, they may be nearly obtained by the following customary method.

Let 3 or 4 men take a boat to 40 or 50 fathoms from the ship; and by a rope, fastened to the stem of the boat, let an iron pot loaded down into the sea, to the depth of 70, 80, or more fathoms where the depth is great, and the boat will by it ride as at anchor; then heave the log, and the number of knots run out in half

a minute, will be the miles the current runs per hour, or the drift; and the bearing of the log from the boat, is the set, or course of the current.

PLANE SAILING.

COMPOUND COURSES, commonly called TRAVERSE SAILING.

PROBLEM I.

A SHIP took her departure from the Lizard, which bore N.N.E. distance seven leagues; she then sailed by a compass which varied two points W. the following courses, to wit. S.S.W. 56 min. S.W. 97, W. 100, S.bE. 196, and S.E.bS. 137. What difference of latitude and departure, course and distance, has she made; and what latitude is she in?

The Lizard bore N.N.E. from the ship, therefore the ship bore from the Lizard S.S.W. distance 21 miles. And because the variation of the compass is 2 points W. or the magnetic meridian 2 points W. of the true North; that is two points towards the left hand, consequently, to correct the above courses, we must reckon from each course steered two points towards the left hand, as under:

Traverse Table.

Course steered.	Course corrected.	Dist.	S.	E.	W.
S.S.W.	S.	77	77,0	—	—
S.W.	S.S.W.	97	89,6	—	37,1
W.	W.S.W.	100	38,3	—	92,4
S.bE.	S.E.bS.	196	163,0	108,9	—
S.E.bS.	S.E.bE.	137	76,2	113,9	—
		Miles.	444,1	222,8	129,5
			—	129,5	—
Made good from the Lizard S. 12° E.		454	444,1	93,3	—

The latitude of Cape Lizard is - - - 49°. 57' N.

The latitude made, or difference of lat. is 7 24 S.

The latitude the ship is in, is - - - 42 33 N.

Solution by Construction, 40 Scale. See Fig. 13.

Fig. 13.

1. Describe a circle; draw the meridian, and the East and West line through its center.
2. Set off from the rumb, the different courses the ship has made, which number in the order as they were made, 1, 2, 3, &c.
3. From the center set off the distance sailed the first course (by laying a ruler on the point A, which represents the place sailed from, and on 1 in the circumference) draw that dist.
4. Take the second distance in the compasses; lay the parallel ruler on the center A, and on 2 in the circumference, and move one side of the parallel ruler till it cut the point of the beginning of the second course, and then set off the distance from that point, the way of the course.
5. Take the next distance in the compasses; lay the ruler on A, and on N°. 3, then move one side parallel to that direction till it cut the point of the beginning of the following course, and set off the distance sailed that course, draw it, and so proceed till all the distances sailed on the different courses are done.

Lastly. Draw a line from the place of the ship at the end of all the courses sailed, to A, and another line draw perpendicular to the meridian, and you will have a triangle by which the difference of latitude and departure, course and distance made good, may be known.

PROBLEM II.

A ship took her departure from Cape St. Vincent, which bore N.E. $\frac{1}{2}$ E. distance assumed five leagues, the variation of the compass $1\frac{1}{2}$ point W. and she steered the courses following,

lowing, N.W.bW. 59'; N.W. 100; W.N.W. 76; W.bN. 140; W. 70; S.W.bS. 45; S.S.W. 29; S. 147; E. 110; N.bE. 57. What course, distance, diff. of latitude and departure has she made from the Cape; and what latitude is she in?

	Course steered.	Corrected.	Dist	N.	S.	E.	W.
Ship from the Cape 1	S.W. 1/2 W.	S.W.bS.	15	—	12,5	—	8,3
2	N.W.bW.	W.N.W. 1/2 W.	59	17,1	—	—	56,4
3	N.W.	N.W.bW. 1/2 W.	100	47,1	—	—	88,2
4	W.N.W. 1/2 W.	W.	76	—	—	—	76,0
5	W.bN.	W. 1/2 S.	140	—	13,8	—	138,8
6	W.	W.S.W. 1/2 W.	70	—	20,3	—	67,0
7	S.W.bS.	S.bW. 1/2 W.	45	—	43,1	—	13,1
8	S.S.W.	S. 1/2 W.	29	—	28,9	—	2,8
9	S. 1/2 W.	S.bE.	147	—	144,2	28,7	—
10	E. 1/2 S.	E.bN.	110	21,5	—	107,9	—
11	N.bE. 1/2 E.	N.	57	57,0	—	—	—
			—	142,7	262,8	136,6	450,1
			—	—	142,7	—	136,6
Made good S. 69° W.			340	—	120,1	—	313,5

Fig. 14.

O B L I Q U E S A I L I N G.

THIS kind of sailing is to be used only when you are within sight of land. The method of application is to take the bearing of one or more objects on the land when your ship makes little or no way, and to note the time; and after having sailed a convenient distance, which let be about the same distance as the furthest object on land was or is from you; then heave the log, and take the bearing of the same object or objects, and note the time you sailed between the observations; by which you must find the distance you have sailed in the elapsed time, and you will then have one side of an oblique angled plane triangle, and all the angles; to find the other two sides, which will be the distances from the object at the first and second times of setting it.

Ex. 1. A ship coasting along shore, at 8h. 30' A.M. the Master observed a wind-mill to bear N.E.bN. the ship sailed N.W. 1/2 W. 4 1/2 knots per 1/2 minute; and at 9h. 30' the mill bore E.N.E. 1/2 E. What distance was the ship from the mill at each time of setting it?

Answer by Projection.

The ship was from the mill at the first time of setting it — — — 5,87 } Miles
At the second ditto — — — — — 6,95 }

By the Figure.

A, the place of the ship, where the first bearing was taken; AN the meridian; B the place of the ship, where the mill bore E.N.E. 1/2 E. at 4,5 miles from A.

The $\angle NAM = 3$ pts. } NS, the meridian of the ship at her second station;
The $\angle NAB = 4 \frac{1}{2}$ } The $\angle NBM = 6 \frac{1}{2}$ pts.
The $\angle BAM = 7 \frac{1}{2}$ } The $\angle SBA = 4 \frac{1}{2}$

Fig. 15.

The sum 11 pts. which subtract from 16, and there will remain 5 points equal to the $\angle ABM$. For the three angles are equal to 16 points. Hence $16 - 12 \frac{1}{2}$, the sum of the angles A and B, gives the angle at M = $3 \frac{1}{2}$ points.

Extend from SR $3 \frac{1}{2}$ to 5 pts. which will reach from 4,5 to 5,87 = AM.

Also $3 \frac{1}{2}$ to $7 \frac{1}{2}$, which will reach from 4,5 to 6,95 = BM, the distances sought,

By Trigonometry, AM is = 5,898 Miles.

Ex.

Ex. 2. Coasting along shore, I saw two capes of land; the bearing of the first was N.b.W. and the second S.E.b.S. $\frac{1}{2}$ E. we sailed W.S.W. 7 miles, and then the first bore N. 38° E. and the second E. 3° Southerly : Required the bearing and distance of these capes from each other.

Solution by Construction.

The capes A and B, bear N.N.W. $\frac{1}{4}$ W. and S.S.E. $\frac{1}{4}$ E. from each other, distance 8,4 miles.

Construction.

Fig. 15. Let C, be the place at her first station, and D her place at her second; C₁ the position of the first cape, and C₂ of the second cape; Ca, Cb, the bearing of the capes from the second station D; from D, draw the lines DA, DB, to cut the position lines, as at A and B, which are the places of the capes, and AB their distance; the position line AB, being reduced to the circle whose center is C, will shew the bearing of the capes from each other; thus draw FG parallel to AB, through the center C, and then FG will have the same bearing as AB, and the chord of the arch NF, will be the degrees of the position or bearing of A from B, which is N. 24° . $30'$ W.

In the triangle ACD, are given the $\angle C = 9$ points; the $\angle D = 29^{\circ}\frac{1}{4}$. Hence $101^{\circ}\frac{1}{4}$

$$\begin{array}{r} + 29^{\circ}\frac{1}{4} \\ \hline \text{Sum } 130^{\circ}\frac{1}{4} \\ \angle A = 49^{\circ}\frac{1}{4} \end{array}$$

$$\text{As } s, 49^{\circ}\frac{1}{4} : s, 29^{\circ}\frac{1}{4} :: DC \ 7' : AC = 4', 55$$

$$\text{And } s, 49^{\circ}\frac{1}{4} : s, 78^{\circ}\frac{3}{4} :: DC \ 7 : AD = 9, 06$$

In the triangle BCD, are given the $\angle C = 9\frac{1}{2}$ points; $\angle D = 25^{\circ}\frac{1}{2}$

$$\begin{array}{r} + 106^{\circ}\frac{3}{4} \\ \hline \text{Sum } 132^{\circ}\frac{1}{4} \\ \angle B = 47^{\circ}\frac{3}{4} \end{array} \left. \begin{array}{l} \text{the } \angle ADC = 29^{\circ}\frac{1}{4} \\ \text{the } \angle BDC = 25^{\circ}\frac{1}{2} \end{array} \right\} \text{the sum is } \angle ADB = 55$$

$$\text{As } s, 47^{\circ}\frac{3}{4} : s, 25^{\circ}\frac{1}{2} :: 7' : 4', 07 = BC$$

$$s, 47^{\circ}\frac{3}{4} : s, 73^{\circ}\frac{1}{4} :: 7 : 9, 056 = BD$$

Note. These proportions were computed by Trigonometry : But the parts required might be obtained by the lines of the sines of the rumbs, and the numbers.

In the triangle ADB are given DA, DB, and the contained angle D : To find AB, and the angles A, B. Because the sides DA, and DB are very near equal to each other, the angles may be taken equal to one another; then $180^{\circ} - 55^{\circ} = 125^{\circ}$, the angles A and B. Whence the angle $A = 62^{\circ}\frac{1}{2} = \angle B$.

D bears from B 3° towards the North from the West.

A from B, W. $65\frac{1}{2}$ N. which is N. $24^{\circ}\frac{1}{2}$ W. the bearing of A from B.

And $s, 62^{\circ}\frac{1}{2} : s, 55^{\circ} :: AD : AB = 8, 37$, the distance of the capes.

P R O B L E M II.

On board a ship in the British Channel, the bearing of a church was observed by the compass to be N.N.E. we then sailed E.b.N. seven miles, and observed the church bore N. What distance was the church from the ship at each place of observation?

Solution by Construction.

Fig. 17. Let A represent the place of the ship, when the first bearing was taken; and B the place at the second bearing; N. the North; C, the church.

Answer. The distance from A to C, at the first time of setting it, is 18,0 miles.

And at the second time, from B, is - - - - - 15,2

By Trigonometry.

In the triangle ABC, are given AB = 7 miles, by the scale marked EP; the $\angle A = 5$ points; $\angle C = 2$ pts. and $\angle B = 9$ points. to find AC and BC.

$$\begin{array}{l} 1. \ s, 2 \text{ pts.} : s, 7 \text{ pts.} :: AB : AC = 17, 94 \\ 2. \ s, 2 \text{ pts.} : s, 5 \text{ pts.} :: AB : BC = 15, 21 \end{array} \left. \vphantom{\begin{array}{l} 1. \\ 2. \end{array}} \right\} \text{the distances required.}$$

By

By the Traverse Table.

By the triangle ABD, the angle at A is 1 pt. and AB 7'; to find AD, BD.

1. Over 7 pts. and against 7 D, is 1,37 S = BD; and 6,87 E = AD, the departure.

2. In the triangle ACD, the angle A is 6 pts. and AD = 6,87, to find AC and CD.

Under 2 pts. and against 6,87 dep. is 16,6 = DC, and 18 = AC.

From DC 16,6

Take DB 1,4

BC = 15,2

Fig. 17.

P R O B L E M III.

Sailing in the British channel, I observed two capes (or head-lands); one of them bore N.N.E. the other N.E.b.E. We sailed E.b.N. till the first bore N.b.W. and the second N. The distance of those capes was known to be 12 miles, and the bearing of the first from the second N.b.W. $\frac{1}{2}$ W. we then continued our course till the capes bore N.b.W. $\frac{1}{2}$ W. the time of sailing this required distance was 1h. 40'. What was the whole distance sailed? What dist. did we sail per hour? What was our nearest distance from the second cape? And what was our distance from the capes at each time of setting them?

Solution by Construction.

Let A and B be the places of the ship at the first and second stations; C, D, the capes. The whole distance sailed is AH = 14 miles nearly.

And if 1h. 40', or 100', give 14 miles

$$60' \text{ will give } 8,4 \quad \left. \begin{array}{l} 60 \\ 8,40 \end{array} \right\}$$

Hence the ship sailed $8\frac{4}{10}$ miles an hour; and the nearest distance from the cape D, was 5,3 miles equal GD. Fig. 18.

Solution by Trigonometry.

In the triangle ADC. 1. As s, 3 pts. : s, $3\frac{1}{2}$ pts. :: 12 : AD = 13,7.

2. As s, 3 pts. : s, $6\frac{1}{2}$ pts. :: 12 : AC = 20,6.

3. In the triangle AGD, right angled at G. To find DG and AG.

By Traverse Table.

Under 2 pts. and against 13,7 dist. is 12,66 = AG, and 5,24 = GD.

4. In the triangle ADH. To find AH.

As s, $7\frac{1}{2}$ pts. : s, $6\frac{1}{2}$ pts. :: AD : AH = 13,2. the whole dist. failed.

By Traverse Table.

5. Under $1\frac{1}{2}$ pts. and against 12 } is DE = 11,5 diff. lat.

} and CE = 3,5 dep.

Otherwise thus: In the triangle BAC, right angled at B.

By Traverse Table.

Over 5 pts. and against 20,6 D, is 11,44 = AB, in lat. col.

* and 17,13 = BC, in dep. col.

In the triangle BDG, right angled at G; under 1 pt. and against 5,24 in lat. col. is 5,35 = BD in dist. col. and 1,04 = BG in dep. col. Also under $\frac{1}{2}$ pt. and against GD, in lat. col. is ,52 = GH, in dep. col. Now AG - GB = AB = 11,62;

And AG + GH = AH = 13,18.

P R O B L E M IV.

We sailed from a port 30 miles E.S.E. when a sudden change of wind obliged us to traverse that course on the N.W.b.N. rumb 23 miles: How far were we then from the port we sailed from? And how did it bear from us?

* Thus, against 20 is 11,11 and 16,63 } the sums are 11,44 and 17,13
And against 0,6 is ,33 and ,50 }
P

Solution,

Solution, by the Traverse Table.

1. Over 6 pts. and against 30m. dist. col. is 11,5S. in lat. and 27,7E. in dep. col.
 2. Under 3 pts. and against 23D. - is 19,1N. - and 12,8W.
- The ship has made from her port - - 7,6N. - and 14,9E. which being found in lat. and dep. columns, gives the bearing of the port sailed from S. 63°W. and its distance 17 miles nearly.

By the Figure.

Fig. 19.

Let NS be the meridian, A the port sailed from, B the place of the ship where she changed her course; and when she had differed her latitude 11,5 S. = AD; and departed from the meridian 27,7 W. = DB. Her second course BC, dist. 23, where she had differed her lat. from B, 19,1 N. = BE = DF, and departed from the meridian 12,8 W. = EC. At C she was 17' from the port A, and it bore S. 63° W. Hence she had made good N. 63° E. 17 miles.

CURRENT SAILING.

1. **A** CURRENT, or Tide, is a progressive motion of the water, which causes all floating bodies to move that way which the stream runs.
2. The setting of a tide, or current, is the point of the compass towards which it runs; and the drift of the current is the rate it runs at per hour, as 1, 2, 3, 4, &c. miles.
3. If the current sets the same way as the course of the ship, then the velocity of the ship, or its motion through the water, is increased (by what she sails by the log) by the drift of the current.
4. If the current sets directly against the course of the ship, her motion through the water is diminished: And if the action of the current exceeds that of sailing by the log with the wind, the ship will drive a-stern and lose way.
5. If the current thwarts the course of the ship (that is, when she sails across the current in any oblique direction, which tends towards the direction of the current) then the velocity of the ship through the water will be increased by it; but if the direction be perpendicular to that of the course, she will fall off the drift of the current per hour from the course; and if the set be between the course and the beam of the ship she will lose way, and the course made by the ship will be compounded of that made by the wind, and that by the current; or of the course steered and distance made by the log, and that of the set and the drift of the current.

P R O B L E M I.

Suppose a ship sailed S.S.W. 10' an hour, in a current that set S.S.W. 3' an hour, she would make S.S.W. 13' an hour, by art. 3.

P R O B L E M II.

Suppose a ship sailed (by the log) 7' an hour N. in a current that set 4' per h. S. then she would make through the water 3' an hour N. by art. 4.

P R O B L E M III.

A ship sailed E.bN. 7' an hour, in a current that set N.bE. 5' an hour: What course and distance did she make good per hour?

By the Traverse Table.

	D.	N.	E.
Course E.bN.	7	1,4	6,9
Current N.bE.	5	4,9	1,0
Made good N. 51° E.	10,1	6,3	7,9

To

To construct the Figure.

Let A be the place of the ship when she entered into the current: Draw AN the meridian, AD the distance failed (by the log) in an hour, E.bN. and AC the drift of the current, N.bE. and parallel to AD draw CB, and parallel to AC, draw DB, and draw the diagonal AB, which will represent the direction of the course made good, and the distance per hour. And the like in all other cases.

P R O B L E M IV.

A ship failed 4 h. due N. by the log $4\frac{1}{2}$ an hour, in a current that set W.S.W. $3\frac{1}{2}$ an hour; she then failed N.N.W. 5 h. by the log $7\frac{1}{2}$ an hour, in a current that set E.bN. $2\frac{3}{4}$ an hour. What course and distance has she made good?

Thus $4\frac{1}{2}$ and $3\frac{1}{2}$	$7\frac{1}{2}$ and $2\frac{3}{4}$
By 4 and 4	By 5 and 5
18 and 14	37,5 and 13,75

Course and Current.	Dist.	N.	S.	E.	W.
N.	18,0	18,0	-	-	-
W.S.W.	14,	-	5,4	-	12,9
N.N.W.	37,5	34,6	-	-	14,3
E.bN.	14,0	2,7	-	13,7	-
Made good N. 15° W.	52'	55,3	5,4	13,7	27,2
		49,9	-	-	13,5

Construction.

1. Set off from A to *a*, 18' due North; and from A to *b*, in the direction of the current, Fig. 20. 14'; draw *bB*, parallel and equal to *Aa*; draw the diagonal AB, and B will be the place of the ship at the end of her first course.
2. Set from N. to *e* and *g*, the direction of the second course and current; draw the parallelogram and its diagonal BC, and C will be her place at the end of the second course.
3. Draw AC, which will be the distance made, and the angle AN*d*, the course made good. Whence her course made good will be found to be N. 15° W. distance 52 miles.

P R O B L E M V.

Suppose a ship fails S.S.E. 7'. an hour, in a current that sets N.W. 4' an hour; What course and distance does she make an hour?

Construction. Let A be the place of the ship entering into the current; AC, the distance Fig. 21. she fails by the log, S.S.E. in an hour; and AD, the set and drift of the current. Draw CB parallel and equal to AD, and draw AB, which will represent the distance made good per hour, and SA*b*, the angle of the course.

By the Traverse Table.

Course and Current.	Dist.	Lat.	Dep.
S.S.E.	7	6,5 S	2,7 E
N.W.	4	2,8 N	2,8 W
Made good S. 2° W.	3,75	3,7 N	0,1 W

P R O B L E M VI.

Suppose a ship failed from a certain cape, S.S.W. 49' by the log, in a current that set between the N. and W. after six hours the same cape bore E.S.E, and by observation the ship had differed her latitude $30'$; I desire the rate the ship failed at, by this compound motion of wind and tide, and upon what point of the compass she has made her way good.

Construction.

Let A represent the place failed from; through the point A, draw the meridian N.S. and Fig. 22. on the point A, describe the semi-circle.

2. Set

2. Set off the course (S.G.) and draw the dist. $49' = AB$.
3. Set off the diff. of lat. $AE = 30'$, and draw EC parallel to AW .
4. Draw the W.N.W. line till it meet the parallel line as in C. Then BC will represent the set and drift of the current, AC the dist. and NAC the course made good, which by the figure is W.N.W. 78 miles.

To find the rate of her sailing: Divide the distance made by the hours of the time that she was under sail, and the quotient will be the answer. Thus $6)78(13$ miles, the rate of sailing made good per hour.

To find (by the Traverse Table) the Dep. and Dist. made good.

Over 6 points, and against $30'$ lat. is 78 distance, and 72 W. departure, the answer. And she has made 13' per hour, W.N.W.

WINDWARD SAILING.

Art. 1. **SAILING** to windward, is sailing towards the quarter the wind blows from, that is, when the course steered is less than 8 pts. from the wind, or from the point the wind blows from; and when a ship sails upon a wind, she makes a (Z) like course, by sailing with the wind, sometimes on one side, and sometimes on the other side of the direction the wind blows from. A person standing at the helm on the quarter-deck, or any where abaft, and looking forwards, towards the stem, or head of the ship; then his right hand side is the starboard side, and his left hand side the larboard side; the beam, is that piece of timber which lies across the middle of the ship, near the main-mast; and if the wind blows from a point between the head of the ship and that beam, it is then said to be before the beam (you are to suppose yourself standing on the middle of the mid-ship beam); but if it blows in a direction between the beam and the after part of the ship, it is abaft.

2. When a ship sails towards that point the wind blows from, she is said to sail on a wind, or to ply to windward: And when she sails as near the wind as she can, she is said to be close hawled; floops will generally sail, when close hawled at 5 points from the wind; but few ships can sail nearer the wind than 6 or $6\frac{1}{2}$ points.

3. When the helmsman is ordered to starboard, he puts the helm of his rudder towards the starboard side, and when he is ordered to port, he puts it towards the larboard side. Windward side is the side the wind blows on. Leeward side is the other side.

4. Tacks and sheets are large ropes made fast to the lower corners of the fore and main sails, (or clues) by which they are hawled fore and aft. When a ship sails on a wind, the windward tacks are hawled forwards, and the leeward sheets aft.

5. The starboard tacks are aboard, when the starboard side is to the windward, and the larboard to the leeward.

6. The larboard tacks are aboard, when the larboard side is to the windward, and the starboard side to the leeward.

7. To find how near the wind a ship can lie, or sail, observe the course she can sail on each tack, when close hawled, and half the number of points between the courses will be the points required.

Ex. 1. The wind at S. and a ship bound to a port 40 leagues directly to windward, she can make her way good at $6\frac{3}{4}$ points from the wind: What distance must she sail on each tack to gain her port?

Solution by Traverse Table.

Given the course $6\frac{3}{4}$ points, and half the difference of latitude 20 leagues, which is = half the distance; to find the dist. to sail: Over $6\frac{3}{4}$ points and against 20 leagues lat. is 82 leagues, the distance to be sailed on each tack.

Construction.

1. With the chord of 60° describe the circle, and draw the diameters N. S. E. and W.

2. Set

N. B. To fetch a port, road, bay, &c. is a sea term; also to gain, or to obtain her port, is the course and distance, or courses and distances, she must sail before she arrives at the place.

2. Set off $6\frac{1}{4}$ points from the point of the wind at S. each way to F and G; and draw the two courses the ship will make on her two boards.

3. Draw AB of a sufficient length, and then lay a parallel ruler on the other tack AF, Fig. 23. and draw from W the other port parallel to AF, till it cut the other line, as in the point B; and AB will be the distance to fail on her larboard tack, and BW on her starboard tack; now AB is equal to 82, the dist. to fail on each tack; which distance is equal to the sum of the several distances Aa, bc, and de; also these distances are equal to those to be failed on the other tack, ab, cd, and eW. that is, the sum of the distances on each tack are equal.

Ex. 2. A ship bound to a port that bears N.E.bN. $\frac{1}{2}$ E, must double a Cape to the Eastward with the wind at N.N.E. after having failed 10 leagues on her larboard tack, $5\frac{1}{2}$ points from the wind, with a point lee-way, the port bore N.W.bW. How near the wind must she lie on her starboard tack? What distance must she fail to reach her port? And what distance was she from the port when she set sail?

Construction.

Let A be the place failed from, B where she tacked, and P the port bound to; draw the circle to represent the horizon, and mark the points N. S. E. W. the point of the wind, the points of the tacks the ship will make good, and the bearing of the port when she changes her tacks. Then set off 10 leagues on her larboard tack, from A to B, and draw BP parallel to the N.W.bW. rumb, till it cut the line AQ, as in the point P, the port required. Fig. 24.

Solution.

As $s, 7\frac{1}{2}$ points : $s, 5$ points :: 10 leagues : $8.4 = BP$. And $s, 7\frac{1}{2}$ points : $s, 2\frac{1}{2}$ points :: 10 leagues : $4.8 = AP$. The sum is the distance to fail equal 13.2. And she may lie at $6\frac{1}{2}$ points from the wind, and make half a point lee-way to fetch her port.

By Traverse Table.

1. 30 dist. and course $5\frac{1}{2}$ gives $26,46 = Be$. $2\frac{1}{2}$ gives $14,14 = Ae$.
2. $14,14$ lat. and course $7\frac{1}{2}$, gives $AP = 14,2$, and $eP = 1,39$. Now $26,46 - 1,39 = 25,07 = BP$, the dist. she must fail to the port, at $6\frac{1}{2}$ pts. from the wind: When she set sail at A, she was 14.4 miles from the port P.

Ex. 3. A ship plying to windward, with the wind at N.W.bN. after failing 45 miles on each tack, found by observation, they had made $30'$ lat. to the Northward: How near the wind did she make her way good?

Construction.

Having drawn the circle, the meridian, and the East and West rumb; then set off the point of the wind, also the lat. made from A to D, and draw DB perpendicular to the meridian, till it cuts the line of position the wind blows from; then take the distance failed on each tack 45, and make the section at C; draw AC, BC, and AG, parallel to BC; then the Arch $Hg = HG$, will be the degrees the ship made her way good from the wind; which is $66\frac{1}{2}$. Fig. 25.

By Traverse Table.

1. Under 3 pts. and against $30'$ lat. is 20 dep. and 36 dist. equal AB.
2. Against 45 in dist. and 18 in dep. col. is the angle $BAC = 66\frac{1}{2}$, that the ship made her course from the wind.

Ex. 4. The wind at North, and a sloop which can lie at 5 points from the wind, and make her course good at $6\frac{1}{2}$, wants to fail to a port 20 miles directly to windward; what course must she fail, and distance on each tack, to reach the port, supposing her first board to be on the larboard tack 10 miles, her second board 20 miles, her third board 20 miles: How far must she fail on her fourth board, so as to make her port on the fifth?

Q

Construction.

Construction.

Fig. 26. With the chord of 60° , describe the Northern half circle, and draw the W. N. and E. rumbs, and set off 20 m. from A to P; from the North point of the circle set off $6\frac{1}{2}$ points each way, and you will have the courses she will make on each board.

Answer from the Construction. She must sail W.N.W. $\frac{1}{2}$ W. on her starboard tacks, and E.N.E. $\frac{1}{2}$ E. on her larboard. Distance $34\frac{1}{2}$ miles on each tack.

Solution by the Traverse Table.

Since she makes her way good at $6\frac{1}{2}$ points from the wind, the courses of her boards will be W.N.W. $\frac{1}{2}$ W. and E.N.E. $\frac{1}{2}$ E. that she will make good; hence to find the distance she must sail to reach her port, may be found as follows: Over $6\frac{1}{2}$ pts. and against 20' lat. is 69' in dist. col. which is the distance she must sail on both boards; whence it appears that she must sail $34\frac{1}{2}$ miles on each. And after she has sailed 20' on her second board, and 20 on her third, she must sail 14,5 on her fourth, and 4,5 on her fifth to the port. For $10 + 20 + 4\frac{1}{2} = 34\frac{1}{2}$ on her larboard tacks; and $20 + 14,5 = 34\frac{1}{2}$ on her starboard.

Ex. 5. A ship is to sail to a port bearing E.S.E. distance 90 miles, with the wind at E.b.S. gets her larboard tacks on board and sails 20 miles; she then tacked and sailed 30: How many miles must she sail on two more boards to obtain her port, supposing the ship to make her way good at 6 points from the wind?

Solution.

Fig. 27. Since she can make her way good on her larboard tack at 5 points from the bearing of the port, and on her starboard at 7; also that the angle opposite to the distance is 4 points, for the sum of the courses she can sail in respect of the position of the distance, is 5 and 7 points; the sum 12, subtracted from 16, leaves 4 points, the angle contained by the tacks, as per fig. Let A be the port to sail from, P the port to sail to; AP the dist. AW the bearing of the wind; the sum of the distances to be sailed on the larboard tack S.b.E. and on the starboard N.E.bN. will be found as follows by the Traverse Table.

Suppose the perpendicular AD, let fall from A upon TP the dist. to be sailed on the starboard tack. See fig. 27.

1. Over 7 points, and against $90' = AP$, in dist. col. is 17,5 = DP, and 88,3 = DA.
2. Under 4 points, and against 88,3 in lat. col. is 125 in dist. col. equal AT, the dist. to sail on the larboard tack; and in dep. col. is 73,0 = DT

Add 17,5 = DP

The dist. to sail on her starboard tack $90,5 = TP$

Remark. When a ship can make her way good, nearer to the bearing of the port on one board than on the other; she must make her longest boards on that tack on which she can make her way the nearest to the bearing of the Port; which is evident by the figure.

It is not material which tack she leads off with; as she must sail 125' on her larboard, and 90,5 on her starboard.

WINDWARD SAILING in a CURRENT.

P R O B L E M I.

A SHIP in the British Channel, making for the Downs, with the wind at E. her course to make is E.bN. dist. 40 miles; the flood tide sets E.N.E. five miles an hour; and the ship can sail by the log account seven miles an hour, and make her boards good at six points from the wind: What courses will she make good? What distances per hour? And what time will she be in sailing to anchor off the * South Foreland?

* For a further Information in this useful part of sailing, I must refer the reader to the Journal through the Channel, from the Downs to Sea, where he will find much variety.

Solution,

Solution.

Since the wind is E. and she makes her way good at 6 points from the wind, therefore she will lie N.N.E. on her starboard tacks, and S.S.E. on her larboard; whence by these, and the set and drift of the current per hour, we find by the traverse table as follows :

		Diff.	N.	E.
Starboard tack 1 h.	N.N.E.	7	6,46 N.	2,68 E.
Current - 1	E.N.E.	5	1,91 N.	4,62 E.
Made good in 1 h.	N.42°E.	11'	8,37 N.	7,30 E.
Larboard tack 1 h.	S.S.E.	7'	6,46 S.	2,68 E.
Current - 1 h.	E.N.E.	5'	1,91 N.	4,62 E.
Made good in 1 h.	S.58°E.	9'	4,55 S.	7,30 E.
Made good in 2 h.	N.75°E.	15'	3,82 N.	14,60 E.

Whence it appears, that she will make her course good by failing equal time on each board; and the ship will make 11' per hour, on her starboard tack, and 9' per hour on her larboard; also by the composition of the courses, and current, at the end of two hours the ship will have made 15' towards the Foreland: Hence if 15 miles require 2 hours, what will 40 miles require? Answer 5 h. 20'. the time sought.

SPHERICAL SAILING.

SPHERICAL Sailing is divided into Parallel Sailing, Middle Latitude, Mercator, and Great Circle.

Def. 1. Parallel failing, is failing East and West, and therefore in a parallel of latitude. See Def. 22. p. 35.

2. Middle Latitude failing, is the method of computing the place of a ship with respect to her longitude, by rules depending on the latitude, taken in the middle between the two latitudes; that is, between the latitude failed from, and the latitude the ship is in.

3. Mercator's failing, is computing the place of a ship in respect of her longitude, by means of a table of meridional parts.

4. Great circle failing, is the computing a ship's way by the position of circular arcs, and their lengths, which are proposed to be failed from one meridian to another, where the course is proposed to be changed a little (a few degrees) from the foregoing.

Rules for Middle Latitude.

1. When the lat. of the place of departure, or place departed from, and that of the place intended to fail to, or arrived at, are of the same name, that is both North, or both South; then half the sum of the latitudes will be the middle latitude.

2. When one of the latitudes is North, and the other South, then half the difference of the latitudes will be the middle latitude.

A SPHERICAL PROBLEM.

Three points that are not in a right line being given; to find the center of the circle. Let Fig. S. *a, b, c*, be the points, through which a circle, or circular arch, is to be drawn; draw right lines from the extreme points, to meet at the middle point, as *ab, cb*; bisect these lines (by Prob. 1.) as the lines *df, gb*, and the point of their intersection, as *C*, will be the center required; on which with the radius *Ca*, describe a circle, and it will pass thro' the pts. required.

A Projection of Half the Surface of the Earth.

THIS projection made on the plane of a meridian, and that of its antipodes (which may be called a projection) on the plane of the rational horizon of a place at the equator. *P* represents the North, and *S* the South poles; *E* the East, and *W* the West points of the horizon; and the line *WE* the equator.

The

The Method of Construction.

Fig. 28.

1st. With the chord of 60° describe the primitive circle P 90, S 90, to represent the horizon of the place O, the center of the projection; draw the axis PS, and the diameter WE for the equator.

2d. Divide the equator into twelve equal parts from O, (6 each way) and mark the points of division, 15° , 30° , 45° , &c.

3d. Describe circular arcs, through each of the points marked in the equator, to co-incide with the poles, by the Spherical Prob. fig. S.

4th. Divide the axis PS, from O to P and S; each part into nine equal parts, and draw lines through these points parallel to the equator; number them 10, 20, &c. to 90, for the degrees of latitude, as per fig.

5th. Set off two parts and $\frac{1}{3}$ from O, towards S and P, and draw two strong lines parallel to the equator EW, for the tropicks of Cancer and Capricorn: Then the lines numbered 10, 20, 30, &c. will represent the parallels of latitude; those towards P, North lat. and those towards S, South latitude.

The circular lines passing from P to S, are meridians, drawn at 15° from each other, in the projection.

SPHERICAL DEFINITIONS and PRINCIPLES.

THE sun at all times of the year, to those at the equator, rises at 6 hours before noon, and sets at 6 hours after; also the sun always rises in the Eastern and sets in the Western horizon. Hence the projection of the Eastern meridian (when the projection is made on the plane of the 6 o'clock meridians) is numbered 6 A.M. and so on to the mid-day meridian POS, and from thence the afternoon hours, to the 6 o'clock meridian in the Western horizon.

A TABLE of the NAUTICAL, or GEOGRAPHICAL MILES, contained in each Degree of Longitude, computed to every Degree of Latitude from the Equator to the Pole.

Lat.	Miles	Lat.	Miles	Lat.	Miles	Lat.	Miles	Lat.	Miles	Lat.	Miles
0°	60	D.		D.		D.		D.		D.	
1	59,99	16	57,67	31	51,43	46	41,68	61	29,09	76	14,51
2	59,96	17	57,38	32	50,88	47	40,92	62	28,17	77	13,50
3	59,91	18	57,06	33	50,32	48	40,15	63	27,24	78	12,48
4	59,85	19	56,73	34	49,74	49	39,36	64	26,30	79	11,45
5	59,77	20	56,38	35	49,15	50	38,57	65	25,36	80	10,42
6	59,67	21	56,01	36	48,54	51	37,76	66	24,41	81	9,38
7	59,56	22	55,63	37	47,92	52	36,94	67	23,44	82	8,35
8	59,43	23	55,23	38	47,28	53	36,11	68	22,48	83	7,32
9	59,27	24	54,81	39	46,63	54	35,27	69	21,50	84	6,28
10	59,09	25	54,38	40	45,96	55	34,41	70	20,32	85	5,23
11	58,89	26	53,93	41	45,28	56	33,55	71	19,53	86	4,18
12	58,68	27	53,46	42	44,59	57	32,68	72	18,54	87	3,14
13	58,46	28	52,97	43	43,88	58	31,79	73	17,54	88	2,09
14	58,22	29	52,47	44	43,16	59	30,90	74	16,54	89	1,05
15	57,95	30	51,96	45	42,43	60	30,00	75	15,53	90	0,00

This table shews in what proportion the degrees of longitude decrease in each degree of the parallel of latitude from the equator to the pole.

Note. In lat 60° there are only 30' in 1° of longitude; but at the equator, where latitude begins, there are 60 geographical miles in 1° .

The

The foregoing table was computed by the following canon :

As R : cof. of the lat. :: 60', the miles in 1° at the equator : the miles in one 1° of longitude in the given parallel of latitude.

Ex. To find the miles in 1° of longitude in the latitude of 5° and of 50°.

As R : cof. 5° = 9,998,344 and R : cof. 50° = 9,808,667.5
 :: 60' = 1,778,151 :: 60' = 1,778,151.3 } 1° lon. in lat. 50° is 38', 567.25
 : 59,77 = 1,776,495 min. in 1° = 38', 667 = 1,586,818.8

A ship sailed from St. Mary's, Scilly, West 576 miles: What longitude is she in?

St. Mary's, lat. 49°.58' N. for which we may take 50°, and against it in the table is 38,57, the miles in one degree. Hence 38,57)57600(14°.36' W. from St. Mary's.

3857 + 6 .40 W. the lon. of St. Mary's.
 19030 21 .16 W. the ship's longitude.
 15428
 36,02

In the lat. of 36°.20', how many miles are there in 10° degrees of longitude?

By table, in 36° are 48,54' in 1° longitude;

And in 37 are 47,92

diff. 1° gives 0,62

Now 20' being $\frac{1}{3}$ of 60, therefore take $\frac{1}{3}$ of the diff. ,62 which is ,21 nearly.

From 48,54

Take ,21

In lat. 36°.20' are 48,33 lon. in 1°, and 483 miles in 10°.

MIDDLE LATITUDE SAILING.

C A S E I.

THE latitudes of two places, and their difference of longitude being given; to find the course and distance.

Required the course and distance between the Lizard and the Isle of St. Vincent.

The lat. of the Lizard is 49°.57' N. and lon. 5°.20' W. from Greenwich.

Lat. of Isle St. Vincent is 17.17 N. and lon. 23.26 W.

Diff. of lat. 1960' = 32.40 diff. of lon. = 18.06 = 1086'

The sum of the latitudes = 67°.14'

The $\frac{1}{2}$ sum is the middle lat. = 33.37

Comp. of middle lat. = 56.23

To construct the Figure.

1st. Draw a meridian line, and set off the diff. of lat. 1960 from A, the represented place of the Lizard to D.

2d. Draw AW perpendicular to AD, which will represent the West rumb; draw DC parallel to AW, and set off from D to C the diff. lon. 1086'; and draw the line AC.

3d. With the sine of 90° in the compasses, and one foot in A, describe the quadrantal arch EW.

4th. Set off the sine of the comp. of the middle lat. from A to m, and draw mm parallel to AW, draw also EG parallel to it.

5th. Take mm in the compasses, and set it from E to P.

R

6th. Draw

} mm = PE
 and By fig. 29.
 } ao = Am.

6th. Draw a right line from A through P, to join the line DC in B, then draw *ed*, and the figure will be constructed.

Note. From this construction may be obtained all the proportions relative to middle latitude sailing, viz.

AD is the difference of latitude = 1960 miles

EG = *mo*, the sine of middle latitude = $33^{\circ}.37'$.

DC the diff. of longitude = 1086 miles

$2158\frac{1}{2}$ = AB, the dist; DB the departure = 920.

ao = *Am*, the cosine, or sine comp. of the middle latitude = $33^{\circ}.37'$.

DAB, the angle of the course.

de, the sine of the course, which is $24^{\circ}.46'$.

Ad, the cosine of the course.

EP, the tangent of the course = $24^{\circ}.46'$.

By similar triangles. See Theo. 12. and the following ones.

Art. 1. AD : DC :: *Am* : *mn* = EP. Whence, as the difference of latitude : the difference of longitude :: cosine middle latitude : the tangent of the course.

2, AE : EG :: *Am* : *mn* or EP, for *mn* = EP. And *Am* : EP as AE : EG; $\therefore$ as DB : DC, and *Am* : AE :: DB : DC.

Hence the cosine of middle lat. : tangent of the course :: diff. of lat. : diff. of lon. And cosine middle latitude : R :: departure : difference of longitude.

3. *Ad* : *Ae* :: AD : AB; that is, the cos. of the course : Rad. :: diff. of lat. : dist.

4. AE : AP :: AD : AB; that is, R : the sec. of the course :: diff. lat. : distance.

The above are general proportions for finding the course, distance, and difference of longitude; and by the 1st, the course was found to the foregoing question, to be $S.24^{\circ}.46'W$. and the distance by the 3d. to be $2158\frac{1}{2}$ miles. I shall leave the other varieties of the cases to be resolved by those who have pleasure in spending time in pursuits of no moment, as this kind of sailing will appear to be, when compared with Mercator's.

To resolve the longitude cases of middle latitude, parallel, and Mercator's sailing, by the traverse table: Enter the table with the nearest degree of middle lat. and find the departure in lat. column; and against it in the distance col. will be found the longitude required; as deduced from the 2d. article above. See figure 29.

Parallel Sailing; or Sailing in a Parallel of Latitude.

C A S E I.

THE latitude and difference of longitude of two places in the same parallel of latitude being given; to find their distance. Suppose two places in the parallel of $50^{\circ}.26'N$. and the diff. of longitude $22^{\circ}.46'$: What is the distance?

To construct the Figure.

Fig. 30. 1. With the sine of 90° . in the compasses, and one foot on the point P, as a center; describe the arch EQ.

2. Set off the difference of longitude, reduced into minutes, from E to Q; and draw the chord line EQ, which bisect, as in F, and erect the perpendicular FP.

3. Set off the sine comp. of the lat. $39^{\circ}.34'$, from the polar point P to A; describe the arc AB, and draw the chord thereof, to represent the distance of the two places in the parallel.

Note. The difference of longitude, and the distances in parallels, are measured by a scale of equal parts; and the sine comp. of the latitudes, by the sines.

From this figure the following proportions will arise.

By

By similar triangles, these proportions. See figure.

1. $PE : EQ :: PA : AB$; that is, Rad. : diff. of lon. :: cos. lat. : dist.
2. $PA : AB :: PE : EQ$; that is, cos. lat. : dist. :: R : diff. of lon.
3. $EQ : EP :: AB : AP$; that is, the diff. of lon. : R :: dist. : cos. of the lat.
4. $AP : aP :: AB : ab$; that is, the cos. of any parallel of lat. : cos. of the parallel of any other lat. :: the dist. in the first parallel : the distance in the second. Thus the cos. of the lat. of A : cos. of the lat. of a :: dist. AB : dist. ab.

And by inverting this last proportion we have, the dist. in any parallel : to the dist. in any other parallel :: the cos. of the lat. of the first parallel : the cos. of the lat. of the second.

These are the various cases of parallel Sailing.

$$\begin{array}{l} \text{By the 1st. } R : \text{cos. lat. } 50^{\circ}.26' = 9,804123 \\ \quad \quad \quad :: \text{diff. lon. } 1366 = 3,135451 \\ \quad \quad \quad : \text{dist. AB } 870 = 2,939574 \end{array}$$

By Traverse Table.

$$\begin{array}{l} \text{Over } 50^{\circ}. \text{ and against } 136,6 \text{ in dist. col. is } 878 \text{ lat. column.} \\ \text{Over } 51^{\circ}. \text{ and against } 136,6 \text{ in do. is } 860 \text{ do.} \\ \text{Mean } 51\frac{1}{2} \text{ and lat. and } 1366' \text{ lon. gives } 869 \text{ the dist.} \end{array}$$

C A S E II.

The latitude and distance between any two places on the same parallel being given; to find the difference of longitude.

A ship sailed from the lat. $48^{\circ}.25'N$. due East 160 leagues: How much did she differ her longitude?

Construct this figure as the last; then P will represent the North pole; the arc EQ Fig. 31. the equator; the chord EQ the measure of the longitude between the meridians of the places; and AB the distance in the latitude of A, the place sailed from; and of B, the place arrived at.

$$\begin{array}{l} \text{As cos. } 48^{\circ}.25' = \text{co-ar. } 0,178023 \\ : R :: \text{dist. } 480' = 2,681241 \\ : \text{diff. of lon. } 723' = 2,859264 \end{array} \text{ Now } 723' = 12^{\circ}.03'E. \text{ she has differed her longitude.}$$

By Traverse Table.

Over 48° and 49° , find 160' in lat. col. and against that you will find 241 in dist. which is the mean of the two. Now 241 multiplied by 3 gives 723 miles diff. lon.

C A S E III.

The difference of longitude between any two places in the same parallel, and the distance, being given; to find the latitude of that parallel.

A ship sailed on a parallel directly West 624 miles, and had then differed her longitude $18^{\circ}.46'$: What was the latitude?

To construct the figure.

First draw a right line, as $FQ = 1126'$, the difference of longitude; bisect it in B, and Fig. 32. draw the perpendicular BP, which make equal to the sine of 90° ; draw the meridians PE, PQ; and set off half the distance each way from B, towards E and Q; and draw the right lines from thence parallel to BP, as aA , bD , to intersect the meridians in the points A and D, which is the latitude of the parallel required.

Take AP in the compasses, and it will measure on the line of sines $33^{\circ}.39'$
Its complement is EA, the lat. $56^{\circ}.21'$.

By

By Trigonometry.

$$\begin{array}{rcl}
 \text{As diff. lon. } 1126' = \text{co-ar. } 6,948462 & & \\
 : \text{Dist. } 624 = & 2,795185 & \\
 \therefore R : \text{cof. lat. } 56^\circ.21' = & \underline{9,743647} &
 \end{array}$$

By Traverse Table.

Find in distance col. 112, and in latitude col. 62; then observe that 1120 is too little, and 1130 too much, and because 1126 lies between them, therefore take (for 6 out of 10) the proportion of the difference in the latitude col. and then 112,6 and 62,4, will give the lat. $56^\circ\frac{1}{3}$, which is sufficiently near the truth.

P R O B L E M I.

Suppose two ships in the lat. 50°N. and 1000 miles from each other, sailed directly North 600 miles: What is the latitude of the parallel arrived at? And what is their difference of longitude? The construction is evident by viewing the figure.

Preparation.

The complement of 1st lat. is $40^\circ.00'$ The diff. of lat. 10.00 N. The complement of 2d lat. 30.00 Hence the lat. is 60.00 N. of the parallel arrived at.1st. As cof. lat. $50^\circ = 9,808067$: dist. 1000 = $3,000000$:: cof. of the 2d parallel $60^\circ = 9,698970$: the dist. in the 2d parallel $778' = 2,890903$ 2d. As the cof. of the lat. $50^\circ = 9,808067$: R :: dist. 1000 = $13,000000$: diff. of lon. $1556 = 3,191933$

By Traverse Table.

1. Over 50° , and against 100,0 is $155\frac{1}{2}$ lon. hence 1000 gives 1555.2. Over 60° , and against 1555 is 778 the dist. but $1556 = 25^\circ.56'$, their diff. of longitude.

P R O B L E M II.

Suppose two ships sailed from the lat. 60°N. (their dist. in the parallel, 350 leagues) directly North, till their distance in the parallel was 175 leagues: What latitude are they in? And what distance has each of them sailed?

As the dist. in the 1st parallel $1050' = \text{co-ar. } 6,978811$: the dist. in the 2d parallel 525 = $2,720159$:: cof. of the lat. of the 1st parallel $60^\circ.00' = 9,698970$: cof. of the lat. of the 2d parallel $75^\circ.31' = 9,397940$ The difference of latitude $15^\circ.31' = 931$ miles, the dist. sailed by each.And they are in the latitude $75^\circ.31'\text{N.}$

By Traverse Table.

Over 60° , and against 350, is 700' lon. now find 700 and 17,5, which will give $75^\circ\frac{1}{2}$, the latitude.

P R O B L E M

P R O B L E M III.

Suppose a ship sailed from the Lizard 100 leagues West, then 100 leagues North, and then 100 leagues East: What latitude and longitude will she be in at the end of these courses?

Answer. She will be in the latitude $54^{\circ}.57'N$. and having differed her longitude $56'E$, therefore she will be in the longitude of $4^{\circ}.19'W$. from the meridian of London, or $4^{\circ}.24'W$. from the meridian of Greenwich.

The Theory, or fundamental Principles of Navigation,

Are clearly deduced and demonstrated from fig. 33. wherein AP represents a meridian; A, a place at the equator, P the pole, AKN an arc of the equator.

Divide the meridian AP into 9 equal parts, and number them 10, 20, 30, &c. to 90; then describe the parallel circles, as CBf, Scg, qDO, &c. and draw the meridians PH, PI, PK, &c. to pass through the points of intersection of the rumb line and the parallels; these will form a number of triangles ABx, BCa, CDb, DEe, &c. which are equal and similar to each other: For the hypotenuses are equal by construction, and the angles ABx, BCa, CDb, &c. are equal, (by Def. 9. p. 34.) Whence all the sides, xB, aC, bD, cE, &c. are equal; and also the sides Ax, Ba, Cb, &c. Now in any one of the triangles, as BCa, (by Trig. Theo. 1. p. 24. and Art. 1. p. 26.) it will be, As radius : BC :: s, $\angle aBC$: oC : Or, R : s, $\angle B$:: CB : Ca, and :: DC : Db, :: ED : Ec, &c. And by composition, R : s, $\angle A$:: AB + BC + CD, &c. : xB + aC + bD, &c. the departure. Hence it follows, that if AG be the distance, PAG is the angle of the course with the meridians, and HB, IC, KD, LE, MF, and NG, the several latitudes corresponding to the equal distances from A to B, B to C, C to D, &c. and NG = AY is the difference of latitude, AN the difference of longitude, GY the parallel distance, or the distance between the meridian of the place you departed from, and that of the place where you are.

P R O P O R T I O N S.

1. R : dist. :: s, course : departure.

For the s, of the $\angle AxB = \text{Rad.}$: dist. AB :: s, course xAB : departure xB.

And R : s, $\angle SAC$:: AC : SC; that is, R : dist. :: cos. course : diff. lat.

For the 1st term is to the 2d, as the 3d is to the 4th term.

And the 1st term is to the 3d, as the 2d is to the 4th.

Also R : diff. lat. :: t, course : dep. (by Theo. 1. of Trig. p. 24.)

Also NG = Ay, the latitude of the parallel yG. And HB, kc, lD, &c. the differences of the latitudes corresponding to the distances AB, BC, &c. Hence in the triangle AHB, or ABx, the $\angle BAH = ABx$, the complement of the course; and HB = AX, the difference of latitude. As s, $\angle ABx$: Ax :: R : dist. AB. Or

2. R : dist. :: s, complement, or cosine of the course : diff. of lat. Ax.

And by composition, R : dist. AG :: cos. course : diff. lat. Ax + Ba + Cb, &c. to G, where the sum is equal Ay, or NG. Whence R : dist. :: s, course : departure, and so is cos. course to diff. of latitude. Alternately cos. course : s, course :: diff. lat. : departure. But by the principles of sines and tangents, cos. : s. :: rad. : tan. Whence.

3. R : tan. course :: diff. lat. : departure. And if the distance, the diff. of latitude, and the departure, be laid down in right lines, they will form a right angled plane triangle; and the square of the distance will be equal to the sum of the squares of the difference of latitude and the departure.

By the figure may be observed the difference between the departure and meridional distance. For in sailing from A to G, or from G to A, the departure is the same; being the sum of the lines xB, aC, bD, &c. which is greater than the meridional distance yG, when a ship sails so as to encrease her latitude; and it is less than the meridional distance AN, when she sails so as to decrease her latitude towards the equator: For all the parts xB, aC, bD, &c.

S

are

are greater than the parts corresponding yr , rs , st , &c. in the parallel; and less than the parts AH , HI , IK , KL , &c. of longitude in the equator.

The departure is a middle quantity between them, and it is a certain quantity for any one course; but if there be several courses between any two places A and G , the whole departure may be different; for if one ship sails from A to y , and from y to G , she makes the departure yG ; but if she sails from A to N , and from N to G , she will make the departure AN . In the former, her meridional distance, in the parallel where she is, is her departure; and in the latter, her meridional distance is her difference of longitude AN , which is greater than her departure in the oblique course AG ; the departure of which is nearly equal to qmo , or meridional distance in the parallel of the middle latitude between N and G ; whence it appears, that the departure is a middle quantity between the meridional distances of the places departed from and arrived at.

4. As $Py : yG :: PA : AN$, or $Py : PA :: yG : AN$; that is, $\cos.$ of the lat. : Radius :: the dist. of any two places in any one parallel : their diff. of longitude.

Dem. The radii of all circles are as the circumferences, or any corresponding parts thereof.

Cor. The miles in one degree of longitude, in any parallel of latitude, is as the $R.$ to the $\cos.$ of the lat. Thus $R : 60'$ (in 1°) at the equator :: the $\cos.$ of any lat. : the miles in 1° of longitude in that parallel of latitude.

5. As $Pq : PA :: qmo : ALN$; that is, $\cos.$ middle lat. : $R :: \text{dep.} : \text{diff. lon.}$

Let AE be the distance sailed, then PS is the $\cos.$ of the latitude, and SR the departure.

And as $R : \text{dist.} :: s, \text{course} : \text{dep.}$ that is, $R : AB + BC + CD, \&c. :: s, xAB : xb + ac + bD, \&c.$ Whence by composition of ratios, the $\cos.$ middle lat. : dist. :: $s, \text{course} : \text{diff. longitude.}$

6. By the 5th proportion, $\cos.$ middle lat. : rad. :: dep. : diff. longitude.

And by the 1st proportion, $R : \text{diff. lat.} :: t, \text{course} : \text{departure.}$

By composition, $\cos.$ middle lat. : diff. lat. :: $t, \text{course} : \text{diff. longitude.}$

And diff. lat. : diff. lon. :: $\cos.$ middle lat. : $t.$ of the course.

As diff. lon. : dist. :: $s, \text{course} : \cos.$ of middle latitude.

Also diff. lon. : diff. lat. :: $t, \text{course} : \cos.$ of mid. lat.

Of WRIGHT's Sailing, commonly called MERCATOR's.

Also of the PRINCIPLES of MERCATOR's CHART.

IF a rectangular piece of paper be turned into the form of a right cylindrical tube, and a sphere inscribed therein, so that the axis of the sphere and cylinder coincide, and the equator to be the line of contact between the said tube and sphere; and that all the points of the surface of the sphere be transferred to and projected on the concave surface of the tube: Then if the paper be opened and laid upon a plane, it will exhibit a Naval Chart, in which the meridians, parallels of latitude, and rumbs, or loxadromics, are all truly and geometrically projected in right lines.

By the 4th proposition above, is demonstrated, that the $\cos.$ of any lat. : $R :: \text{dist. of any two meridians in the parallel} : \text{their diff. of longitude.}$

(By fig. 21.) Let PAE be a quadrantal arch, P the pole, E a place at the equator, and C the center of the earth.

1. As $CO : CA :: CE : Ck$; that is, $\cos.$ lat. : $R :: R : \text{secant of the latitude.}$

2. $CO : OA :: CE : Ek$; that is, $\cos.$ lat. : $s, \text{lat.} :: R : \text{tan. of the latitude.}$

Also, because the triangles PCt , and TCE are similar, their sides are proportional. Thus PC is parallel to TE , therefore the $\angle PCt = CTE$, (by Theo. 3. and 22. which see.)

3. And

3. And $Pt : PC :: EC : ET$; that is, the tan. of an arc : $R :: R : \text{co-tangent}$.

Remark. In any proportion where the 1st and 2d, or 1st and 3d terms, are the same as those in any other proportion, that you may take the two terms in one proportion, and cast off the terms which have the same ratio in the other; by which you may generally have the radius for the 1st term; which in spherical trigonometry will be very advantageous.

To find the meridional parts to any degree of latitude.

Rule. As the miles in 1° of longitude in any parallel of latitude : 60, the miles in 1° of longitude at the equator :: 60' the enlarged degree of longitude in the parallel : the enlarged degree of latitude, or meridional parts for a degree in that latitude.

Note. That half of the degree of latitude is to be reckoned to or towards the South, and the other to or towards the North of the given parallel.

$$\begin{aligned}\text{Thus } R : \text{cof. lat. } 50^\circ &= 9,8080675 \\ &:: \text{log. of } 60' = 1,7781513 \\ &: 38,567 = 1,5862188\end{aligned}$$

Hence the miles in 1° of longitude in the latitude 50° . is $38\frac{567}{1000}$ miles.

As $38,567 : 60' :: 60' : 93,34$, the meridional parts in 1° from lat. $49^\circ\frac{1}{2}$ to $50^\circ\frac{1}{2}$: Or by the 1st proportion above, $R : \text{sec. lat.} :: 60$ the minutes in 1° of longitude : the meridional parts in 1° of that latitude.

Thus ($R=1$) by natural numbers, As $1 : 1,55572 : 60 : 93,3434$ meridional parts.

By artificial numbers, As $10 : 10,19193$ the sec. of 50° . lat.

$$\begin{aligned}&:: \text{log. of } 60' = 1,77815 \\ &: \text{mer. pts. for } 49^\circ\frac{1}{2} \text{ to } 50^\circ\frac{1}{2} = 93,345 = 2,97008 \\ &R : \text{sec. } 60^\circ = 10,30103 \text{ lat. } 60^\circ, \\ &:: 60' \text{ lon.} = 1,77815 \\ &: \text{mer. pts. in } 1^\circ = 120 = 2,07918\end{aligned}$$

Remark 1. That the tables of meridional parts are (composed of) a collection of the secants of each degree and minute of latitude.

2. $360^\circ \times 69,08 = 24868,8$ English miles round the earth.

3. $69,08 : 60' :: 24868,8 : 21600$ nautical miles circumference. Hence 6875,5 the nautical diameter, and 3438- the Radius.

MERCATOR'S SAILING:

CASE I.

THE lat. and lon. of two places being given, to find the course and distance between them.

Required the course and distance between the Lizard, in the lat. of $49^\circ.57'N$. and Port-Royal in Jamaica, whose lat. is $18^\circ.N$. and lon. $71^\circ.2'W$. from the Lizard.

Cape Lizard, lat. $49^\circ.57'N$.	Meridional parts 3470	Diff. lon. - - $71^\circ.2'$
Port-Royal - $18^\circ.0'N$.	1098	60
Proper diff. lat. 31.57	Mer. diff. lat. 2372	Diff. lon. in min. 4262
60		
Miles = 1917 proper diff. lat.		

Fig. 30.]

$$\begin{aligned}\text{As Mer diff. lat. } 2372 &= \text{co-ar. } 6,624885 \\ : R :: \text{diff. lon. } 4262 &= 3,629613 \\ : \text{t. course } 60^\circ.54 &= 10,254498\end{aligned}$$

R : diff.

$$\begin{array}{l} R : \text{diff. lat. } 1917 = 3,282622 \\ :: \text{sec. course } 60^{\circ}.54' = 10,313064 \\ : \text{dist. } 3942 = 3,595686 \end{array}$$

$$\begin{array}{l} \text{Or thus, As cos. course } 60^{\circ}.54' = 9,686936 \\ : \text{diff. lat. } 1917 = 3,282622 \\ :: R : \text{dist. } 3942 = 3,595686 \end{array}$$

The Meridian AB, is the proper diff. of latitude, and AD, the meridional diff. of lat. AC, the true distance, and AE, the enlarged distance. BC, the departure, and DE, the diff. of longitude. CAB, the angle of the course.

By Middle Latitude.

$$\begin{array}{l} \text{Lat. Lizard} = 49^{\circ}.57' \\ \text{Lat. Port-Royal } 18^{\circ}.00' \\ \text{Sum } 67.57 \\ \frac{1}{2} \text{ sum is middle lat. } 33.58\frac{1}{2} \end{array}$$

$$\begin{array}{l} \text{As diff. lat. } 1917 = 6,717378 \\ : \text{Diff. lon. } 4262 = 3,629613 \\ :: \text{Cos. mid. lat. } 33^{\circ}.58'\frac{1}{2} = 9,918702 \\ : \text{Tan. course } 61.31 = 10,265693 \\ \text{And cos. course } 61^{\circ}.31' = \text{co-ar. } 0,321573 \\ : \text{Diff. lat. } 1917 = 3,282622 \\ :: R : \text{dist. } 4020 = 3,604195 \end{array}$$

By the Traverse Table.

Find the meridional parts, and the longitude, in lat. and dep. columns, and then find the difference of latitude in lat. col. and you will have the course $S.61^{\circ}W.$ and dist. 3950 miles, taking the diff. of lat. as a mean between 18,9 and 19,4, which gives 39,5; and each of these multiplied by 100, gives 3950 dist. 3455 dep. 1915 lat. which is much nearer the truth than middle latitude, and sufficiently near for any distance and course.

N. B. That the latitude and meridional parts are always to be found in lat. col. and the departure and longitude in dep. col. the course at the top, when less than 4 pts. if more, at the bottom of the table: Also that dist. lat. and dep. are always to be found adjacent to each other, and in the same horizon line; and the like of meridional parts and longitude.

C A S E II.

The course and distance sailed from a known latitude being given, to find the difference of latitude, and difference of longitude.

A ship from the lat. of $18^{\circ} N.$ sailed $N60^{\circ}.54'E.$ 3942 miles: Required the lat. come to, and how much she has altered her longitude.

Fig. 31.

$$\begin{array}{l} 1. \text{ As } R : \text{dist. } 3942 = 3,595717 \\ : \text{Cos. course } 60^{\circ}.54' = 9,686935 \\ : \text{Proper diff. lat. } 1917 = 3,282652 \end{array} \quad \begin{array}{l} 2. : R : \text{mer. diff. lat. } 2372 = 3,375115 \\ : \text{Tan. course } 60^{\circ}.54' = 10,254462 \\ : \text{Diff. lon. } 4262 = 3,629577 \end{array}$$

By Middle Latitude.

The proper difference of latitude is obtained as above; therefore to find the difference of longitude,

$$\begin{array}{l} \text{As cos. mid. lat. } 33^{\circ}.58'\frac{1}{2} = \text{co-ar. } 0,08130 \\ : \text{Tan. course } 60^{\circ}.54' = 10,25446 \\ : \text{Diff. lat. } 1917 = 3,28262 \\ : \text{Diff. lon. } 4153 = 3,61838 \\ \text{Ditto by mer. } 4262 \\ \text{Error of lon. } 109 \end{array}$$

By Traverse Table.

Over the nearest number of degrees to the course, which is 61° . find 39 in dist. col. then because the dist. is 3942, I take 3950, which answers to, or gives, the mean of the diff. lat. 1915; now look for the meridional parts 2372 in lat. col. and you will have 4270 in dep. col. the diff. of longitude, which is sufficient for the purpose.

C A S E

C A S E III.

The course and both latitudes given, to find the distance and difference of longitude.

Fig. 32.

A ship from the lat. $49^{\circ}.40'N$. under the meridian of the Lizard, made her way good to the equator, with the course $S. 6^{\circ}.W$. Required her dist. sailed, and diff. of longitude.

Lat. from $49^{\circ}.40'N$	: Cos. course $6^{\circ} = 0,002386$
60	: diff. lat. $2980 = 3,474216$
2980 proper diff. lat.	:: R : dist. $2997 = 3,476602$
3443 mer. diff. lat.	: R : mer. diff. lat. $3443 = 3,536937$
the $\frac{1}{2}$ of $49^{\circ}.40'$ is	:: tang. course $6^{\circ} = 9,021620$
the mid. lat. 24.50	: diff. lon. $361,9 = 2,558557$

By Middle Latitude.

The proper diff. of lat. as above.

For diff. lon. As cos. mid. lat. $24^{\circ}.50' = 0,042138$
: tang. course $6^{\circ} = 9,021620$
:: diff. lat. $2980 = 3,474216$
: diff. lon. $345 = 2,537974$

By Traverse Table.

Under 6° . and against 29,8 lat. is 30 dist. hence the dist. is 3000 miles. But if the diff. lat. be taken in the last col. of lat. under 6° . the dist. will be 2995'; which is only 2' less than the distance by Mercator's method of computing; and the former is 3' more than by Mercator's.

In the same col. of lat. find 34,4, and against it, or for it, you will have 3,6 or 3,66; but as the meridional parts are 344,3, the longitude will be 366, which is 4' more than by Mercator's.

C A S E IV.

Both latitudes and dist. given, to find the course and diff. of lon.

Fig. 33.

A ship in the lat. $10^{\circ}S$. and lon. $20^{\circ}E$. is bound to a port in lat. $43^{\circ}N$. dist. 4353 miles in the Eastern quarter: Required the course and diff. lon. the ship has to make.

Ship's lat. $10^{\circ}S$.	Mer. parts - 603
Lat. for $43^{\circ}N$.	2863
Diff. lat. 53	Mer. diff. lat. 3466
x 60	
prop. diff. lat. 3180	

As Dist. $4353 = \text{co-ar. } 6,361211$	R : mer. diff. lat. $3466 = 3,539828$
: R :: diff. lat. $3180 = 3,502427$	:: tan. course $43^{\circ}.4' = 9,970668$
: cos. course $43^{\circ}.4' = 9,863638$	: diff. lon. $3240 = 3,510596$

By Traverse Table.

1. Find 43,5 in dist. col. which is the mean between 43 and 44, and find in lat. col. the nearest number to 31,8, and the course will be found to be $N.43^{\circ}E$.

2. Against mer. diff. lat. 34,7 is 32,4 lon. in dep. col. which multiplied by 100, gives 3240 diff. lon.

C A S E V.

Given one latitude, course and difference of longitude; to find the other latitude, and distance sailed.

A ship from the lat. $60^{\circ}N$. sailed $S.53^{\circ}.19'W$. till she was found to have differed her lon. $160^{\circ}W$. Required the latitude she is in, and the distance sailed.

T

By

By Mercator's.

As s, course $53^{\circ}.19' = 0,095853$
 : diff. lon. 9600 = 3,982271
 :: cos. course $53^{\circ}.19' = 9,776259$
 : Mer. diff. lat. $7151 = 3,854383$

Lat. from $60^{\circ}\text{N.} = 4527$ mer. pts. $60^{\circ}.00'$ lat. N.

Mer. diff. lat. = 7151

Diff. = 2624 gives $40^{\circ}.01'$ in S.Sum $100^{\circ}.01' = 6001'$ As cos. course $53^{\circ}.19' = 0,223741$

: proper diff. lat. 6001 = 3,778224

:: R : dist. 10045 = 4,001965

By Traverse Table.

Find the numbers to $4\frac{3}{4}$ pts. which is nearer the course than 53° , it being 7' only too great, and 53° is 19' too little

Thus, over $4\frac{3}{4}$ pts. and against 9600 is 7120And over 53° and against do. is 7238Diff. 26' gives the diff 118 mer. pts.

Now say, As 26' : 118 :: 7' : 32 nearly

Add 7120

Mer. diff. lat. 7152 by which the lat. in, will be found to be $40^{\circ}.02'\text{S.}$

C A S E VI.

Fig. 35. One latitude, course and departure given, to find the other latitude, and the difference of longitude.

A ship from the lat. 40°S. sailed $\text{N. } 53^{\circ}.19'\text{E.}$ till her dep. was 8055 miles : Required the latitude come to, and her difference of longitude.

1. As s, course $53^{\circ}.19' = \text{co-ar. } 0,095853$
 : dep. 8055 = 3,906065
 :: cos. course $53^{\circ}.19' = 9,776259$
 : proper diff. lat. 6000 = 3,778177

2. As R : Mer. diff. 7151 = 3,854367
 :: t, course $53^{\circ}.19' = 10,127887$
 : diff. lon. 9600 = 3,982254

Lat. sailed from 40°S.
 Diff. lat. made 100N.
 Lat. in 60°N.
 Excess of lat. 20°N.
 $\frac{1}{2}$ is mid. lat. 10°N.

Diff. Lon.
 By Mercator 9600
 By mid. lat. 8181
 Diff. = $23^{\circ}.39' = 1419$

3. As cos. middle lat. $10^{\circ} = 0,006649$
 : dep. 8055 = 3,906065
 :: R : diff. lon. 8181 = 3,912714

By Traverse Table.

Over 53° and against 8055 dep. is diff. lat. 6060. And against 7151 is 9500, the diff. of lon.Over $4\frac{3}{4}$ pts. and against 8055, is 5980.

And against 7151 is 9640 diff. of lon.

Diff. 140

Now say, As 26' : 140 :: 7' : 38 its proportional part.

From 9640

Take 38

Diff. of lon. 9602 which is sufficient, being only 2' more than Mercator's.

C A S E VII.

Both latitudes and departure given, to find the course, distance, and diff. of longitude.

A ship from the lat. 40°N. sailed between the S. and E. till her dep. was 8055 miles, and by observation was found to be in the lat. 60°S. Required the course, dist. and diff. lon. (See fig. 35.)

1. As

$$\begin{array}{l}
 1. \text{ As proper diff. lat. } 6000 = \text{co-ar. } 6,221849 \\
 : R :: \text{ dep. } 8055 = 3,906065 \\
 : \text{ tan. course } 53^\circ.19' = 10,127914
 \end{array}$$

$$\begin{array}{l}
 2. \text{ As s, course } 53^\circ.19' = 0,095853 \\
 : \text{ dep. } 8055 = 3,906065 \\
 :: R : \text{ dist. } 10445 = 4,001918
 \end{array}$$

By Middle Latitude.

$$\begin{array}{l}
 3. R : \text{ mer. diff. lat. } 7150 = 3,854306 \\
 :: \text{ t, course } 53^\circ.19' = 10,127817 \\
 : \text{ diff. lon. } 9597 = 3,982123
 \end{array}$$

$$\begin{array}{l}
 4. \text{ As cof. mid. lat. } 10^\circ.00' = 0,006649 \\
 : \text{ tan. course } 53^\circ.19' = 10,127817 \\
 :: \text{ diff. lat. } 6000 = 3,778151 \\
 : \text{ diff. lon. } 8177 = 3,912617
 \end{array}$$

The course and dist. obtained as above.

Diff. lon. by Mercator 9597

Ditto by mid. lat. 8177

Diff. = $23^\circ.40' = 1420$ error by mid. lat.

By Traverse Table.

Against 60 lat. and 80,5 dep. is the course 53° . and dist. 10050. Also against 7150 is 9500 diff. lon.

And against 60 and 80,5 is $4\frac{3}{4}$ pts. dist. 10100. Also against 7150 is 9640, the diff. lon. This proportioned as in Case 6. will give the diff. of lon. 9602.

C A S E VIII.

One latitude, distance, and departure given, to find the other latitude, diff. of longitude, Fig. 36. and course.

A ship from the lat. 10°S . sailed between the S. and W. 4353 miles, she departed from the meridian 2973 miles: Required the latitude come to, and diff. of lon.

$$\begin{array}{l}
 \text{As dist. } 4353 = 6,361211 \\
 : R :: \text{ dep. } 2973 = 3,473195 \\
 : \text{ s, course } 43^\circ.05' = 9,864406
 \end{array}$$

$$\begin{array}{l}
 \text{As s, course } 43^\circ.05' = 0,165541 \\
 : \text{ dep. } 2973 = 3,473195 \\
 :: \text{ cof. course } 43^\circ.05' = 9,863537 \\
 : \text{ proper diff. lat. } 3179 = 3,502273
 \end{array}$$

$$\begin{array}{l}
 \text{Lat. sailed from } 10^\circ.00'\text{S.} = 0603 \\
 \text{Diff. lat. made } 52.59\text{S.} \\
 \text{Lat. in } 62.59\text{S.} = 4903 \\
 \text{Merid. diff. lat.} \quad - \quad - \quad - \quad 4300
 \end{array}$$

$$\begin{array}{l}
 : R : \text{ mer. diff. lat. } 4300 = 3,633468 \\
 :: \text{ t, course } 43^\circ.05' = 9,970922 \\
 : \text{ diff. lon. } 4022 = 3,604390
 \end{array}$$

$$\begin{array}{l}
 \text{Or thus, As cof. course } 43^\circ.05' = 0,136462 \\
 : \text{ s, course } 43.05 = 9,834460 \\
 :: \text{ mer. diff. lat. } 4300 = 3,633468 \\
 : \text{ diff. lon. } 4022 = 3,604390
 \end{array}$$

By Middle latitude.

$$\begin{array}{l}
 : \text{ cof. mid. lat. } 36^\circ.29' = 0,094728 \\
 : \text{ tan. course } 43.05 = 9,970922 \\
 :: \text{ diff. lat. } 3179 = 3,502273 \\
 : \text{ diff. lon. } 3698 = 3,567923
 \end{array}$$

Lon. by Mercator 4022

Ditto by mid. lat. 3698

Diff. $5^\circ.24' = 324$ error by mid. lat.

By Traverse Table.

Against dist. 4353, and dep. 2973, is 3180 diff. lat. and over these is the course $\text{S. } 43^\circ\text{W}$. Also against mer. diff. lat. 4300 is 4020 diff. of longitude.

Thus, against 43 dist. and dep. 29,3 is 31,4 lat. Also the course 43° . these proportioned will be as above.

To

To make a PLANE CHART, and to prick off the Place of a Ship in it.

First, **Y**OU are to resolve on the size the plan is to be, and what particular parts of the earth's surface is to be laid down in it; whether it is to be a chart of use in pricking off the places of a ship each day (at noon) as she passes from one port to another, or if it is to be a general chart, or eye-plan of the situation, &c. of places; such charts may be laid down with 10° . in an inch, both in latitude and longitude, or meridional distance.

These charts may be laid down by a scale of 10 equal parts in an inch, when each part denotes 1° . and each part on the 20 scale $\frac{1}{2}$ a degree; and each part on the 40 scale $\frac{1}{4}$ of a degree. This chart will not be much defective in places between the equator and 24 degrees of latitude North and South, but very erroneous in greater latitudes, where the Mercator's projection is to be used, or some projection of a spherical form.

To construct the chart.

1. Draw a line with a pencil near the middle of the paper, to represent the meridian.
2. Mark some point in it, from which the latitudes are to be set off (*), and draw a line through that point perpendicular to the meridian, for the East and West line of measures of the chart.
3. Set off from the point (*) 10° , 20° , 30° , &c. each way, both in the meridian, and in the East and West line, and draw lines parallel to the East and West line through each 10° , to represent parallels of latitude; draw also lines through each 10° of meridional distance, parallel to the meridian first drawn, which will also be meridians of the different degrees of longitude.

But more generally plans of this kind are laid down in the following manner:

1. Having got the size of the paper, and the degrees of latitude and longitude of the parts to be laid on it; deduct $1\frac{1}{2}$ or 2 inches from the length, also from the breadth of the paper, and then say, If the number of degrees to be laid down on the plan, whether of longitude or latitude, require such a number of inches, what will 1, 2, 3, 4, 5, 10, &c. degrees require in inches and parts of an inch; which being done, draw a meridian near one side of the paper, and an East and West line near its bottom, and set off the degrees of latitude and longitude in these lines, and draw the other meridians and parallels of latitude; and then subdivide the meridians on the East and West sides, also the longitude lines at the top and bottom into single degrees; and if the size of the scale will admit, divide them into $\frac{1}{2}$ and $\frac{1}{4}$ degrees: In some plans the small divisions are each a minute; and in others they are each 5 or 10 minutes, according to what is required to be shewn by it.

Having numbered the latitude lines on the sides of the plan, and the longitude lines at the top and bottom; and wrote on the East side of the first meridian, East longitude; and West longitude on the West side; then lay down the places of ports, headlands, capes, &c. and draw the sea-coast: You are then to fix on the point or points from which you are to draw a compass, or any requisite number of them, according to the extent of the chart.

Note. The points of the compass may be accordingly obtained by continual bisection; that is, having drawn a circle and its two diameters perpendicular to each other; then bisect each quadrantal arc, and draw the N.E. S.W. and the N.W. S.E. rumbs, and then bisect the remaining arches, and draw the N.N.E. S.S.W. and the N.N.W. S.S.E. also the W.N.W. E.S.E. and E.N.E. W.S.W. and then bisect the remaining arcs, and draw the residue of the points or rumbs (as in the chart, No. 1.) and the plan will be finished.

1. Remark. That the degrees of latitude, and of meridional distance, in plane charts, are equal to each other; therefore they are both to be measured by the same scale, or line of meridional distance.

2. The names of places to be wrote towards the mark which denotes the place.

M E R I-

MERIDIONAL PARTS.

77

D. 1.	0	1	2	3	4	5	6	7	8	9	10	11	D. 1.
1	0,0	60,0	120,0	180,1	240,2	300,4	360,7	421,1	481,6	542,2	603,1	664,1	1
2	1,0	61,0	121,0	181,1	241,2	301,4	361,7	422,1	482,6	543,3	604,1	665,1	2
3	2,0	62,0	122,0	182,1	242,2	302,4	362,7	423,1	483,6	544,3	605,1	666,1	3
4	3,0	63,0	123,0	183,1	243,2	303,4	363,7	424,1	484,6	545,3	606,1	667,1	4
5	4,0	64,0	124,0	184,1	244,2	304,4	364,7	425,1	485,6	546,3	607,1	668,1	5
6	5,0	65,0	125,0	185,1	245,2	305,4	365,7	426,1	486,6	547,3	608,2	669,2	6
7	6,0	66,0	126,0	186,1	246,2	306,4	366,7	427,1	487,6	548,3	609,2	670,2	7
8	7,0	67,0	127,0	187,1	247,2	307,4	367,7	428,1	488,6	549,3	610,2	671,2	8
9	8,0	68,0	128,0	188,1	248,2	308,4	368,7	429,1	489,6	550,3	611,2	672,2	9
10	9,0	69,0	129,0	189,1	249,2	309,4	369,7	430,1	490,7	551,4	612,2	673,2	10
11	10,0	70,0	130,0	190,1	250,2	310,4	370,7	431,1	491,7	552,4	613,2	674,3	11
12	11,0	71,0	131,0	191,1	251,2	311,4	371,7	432,1	492,7	553,4	614,2	675,3	12
13	12,0	72,0	132,0	192,1	252,2	312,4	372,7	433,1	493,7	554,4	615,3	676,3	13
14	13,0	73,0	133,0	193,1	253,2	313,4	373,7	434,2	494,7	555,4	616,3	677,3	14
15	14,0	74,0	134,0	194,1	254,2	314,4	374,7	435,2	495,7	556,4	617,3	678,4	15
16	15,0	75,0	135,0	195,1	255,2	315,4	375,8	436,2	496,7	557,4	618,3	679,4	16
17	16,0	76,0	136,0	196,1	256,2	316,4	376,8	437,2	497,7	558,4	619,3	680,4	17
18	17,0	77,0	137,0	197,1	257,2	317,5	377,8	438,2	498,7	559,4	620,3	681,4	18
19	18,0	78,0	138,0	198,1	258,2	318,5	378,8	439,2	499,8	560,5	621,3	682,4	19
20	19,0	79,0	139,0	199,1	259,2	319,5	379,8	440,2	500,8	561,5	622,4	683,4	20
21	20,0	80,0	140,0	200,1	260,2	320,5	380,8	441,2	501,8	562,5	623,4	684,5	21
22	21,0	81,0	141,0	201,1	261,3	321,5	381,8	442,2	502,8	563,5	624,4	685,5	22
23	22,0	82,0	142,0	202,1	262,3	322,5	382,8	443,2	503,8	564,5	625,4	686,5	23
24	23,0	83,0	143,0	203,1	263,3	323,5	383,8	444,2	504,8	565,5	626,4	687,5	24
25	24,0	84,0	144,0	204,1	264,3	324,5	384,8	445,2	505,8	566,6	627,4	688,6	25
26	25,0	85,0	145,0	205,1	265,3	325,5	385,8	446,3	506,8	567,6	628,5	689,6	26
27	26,0	86,0	146,0	206,1	266,3	326,5	386,8	447,3	507,8	568,6	629,5	690,6	27
28	27,0	87,0	147,0	207,1	267,3	327,5	387,8	448,3	508,9	569,6	630,5	691,6	28
29	28,0	88,0	148,0	208,1	268,3	328,5	388,8	449,3	509,9	570,6	631,5	692,6	29
30	29,0	89,0	149,0	209,1	269,3	329,5	389,8	450,3	510,9	571,6	632,5	693,6	30
31	30,0	90,0	150,1	210,1	270,3	330,5	390,8	451,3	511,9	572,6	633,5	694,7	31
32	31,0	91,0	151,1	211,1	271,3	331,5	391,8	452,3	512,9	573,7	634,6	695,7	32
33	32,0	92,0	152,1	212,1	272,3	332,5	392,9	453,3	513,9	574,7	635,6	696,7	33
34	33,0	93,0	153,1	213,1	273,3	333,5	393,9	454,3	514,9	575,7	636,6	697,7	34
35	34,0	94,0	154,1	214,1	274,3	334,5	394,9	455,3	515,9	576,7	637,6	698,7	35
36	35,0	95,0	155,1	215,1	275,3	335,5	395,9	456,3	516,9	577,7	638,6	699,8	36
37	36,0	96,0	156,1	216,1	276,3	336,5	396,9	457,3	518,0	578,7	639,6	700,8	37
38	37,0	97,0	157,1	217,1	277,3	337,5	397,9	458,4	519,0	579,7	640,7	701,8	38
39	38,0	98,0	158,1	218,1	278,3	338,5	398,9	459,4	520,0	580,8	641,7	702,8	39
40	39,0	99,0	159,1	219,1	279,3	339,6	399,9	460,4	521,0	581,8	642,7	703,8	40
41	40,0	100,0	160,1	220,2	280,3	340,6	400,9	461,4	522,0	582,8	643,7	704,9	41
42	41,0	101,0	161,1	221,2	281,3	341,6	401,9	462,4	523,0	583,8	644,7	705,9	42
43	42,0	102,0	162,1	222,2	282,3	342,6	402,9	463,4	524,0	584,8	645,8	706,9	43
44	43,0	103,0	163,1	223,2	283,3	343,6	403,9	464,4	525,0	585,8	646,8	707,9	44
45	44,0	104,0	164,1	224,2	284,3	344,6	404,9	465,4	526,0	586,8	647,8	709,0	45
46	45,0	105,0	165,1	225,2	285,3	345,6	405,9	466,4	527,1	587,9	648,8	710,0	46
47	46,0	106,0	166,1	226,2	286,3	346,6	407,0	467,4	528,1	588,9	649,8	711,0	47
48	47,0	107,0	167,1	227,2	287,3	347,6	408,0	468,4	529,1	589,9	650,8	712,0	48
49	48,0	108,0	168,1	228,2	288,3	348,6	409,0	469,5	530,1	590,9	651,9	713,0	49
50	49,0	109,0	169,1	229,2	289,3	349,6	410,0	470,5	531,1	591,9	652,9	714,1	50
51	50,0	110,0	170,1	230,2	290,3	350,6	411,0	471,5	532,1	592,9	653,9	715,1	51
52	51,0	111,0	171,1	231,2	291,3	351,6	412,0	472,5	533,1	593,9	654,9	716,1	52
53	52,0	112,0	172,1	232,2	292,4	352,6	413,0	473,5	534,1	595,0	655,9	717,1	53
54	53,0	113,0	173,1	233,2	293,4	353,6	414,0	474,5	535,1	596,0	657,0	718,2	54
55	54,0	114,0	174,1	234,2	294,4	354,6	415,0	475,5	536,2	597,0	658,0	719,2	55
56	55,0	115,0	175,1	235,2	295,4	355,6	416,0	476,5	537,2	598,0	659,0	720,2	56
57	56,0	116,0	176,1	236,2	296,4	356,6	417,0	477,5	538,2	599,0	660,0	721,2	57
58	57,0	117,0	177,1	237,2	297,4	357,6	418,0	478,5	539,2	600,0	661,0	722,3	58
59	58,0	118,0	178,1	238,2	298,4	358,6	419,0	479,5	540,2	601,0	662,1	723,3	59
60	59,0	119,0	179,1	239,2	299,4	359,6	420,0	480,5	541,2	602,1	663,1	724,3	60
D. 1.	0	1	2	3	4	5	6	7	8	9	10	11	D. 1.

D.1.	12	13	14	15	16	17	18	19	20	21	22	23	D.1.
1	725,3	786,8	848,5	910,5	972,8	1035,3	1098,2	1161,5	1225,1	1289,2	1353,7	1418,6	1
2	726,4	787,8	849,5	911,5	973,8	1036,3	1099,3	1162,5	1226,2	1290,3	1354,8	1419,7	2
3	727,4	788,8	850,5	912,6	974,8	1037,4	1100,3	1163,5	1227,3	1291,3	1355,8	1420,8	3
4	728,4	789,9	851,6	913,6	975,9	1038,4	1101,4	1164,6	1228,3	1292,4	1356,9	1421,9	4
5	729,4	790,9	852,6	914,6	976,9	1039,5	1102,4	1165,7	1229,4	1293,5	1358,0	1423,0	5
6	730,5	791,9	853,6	915,7	978,0	1040,5	1103,5	1166,7	1230,4	1294,5	1359,0	1424,1	6
7	731,5	792,9	854,7	916,7	979,0	1041,6	1104,5	1167,8	1231,5	1295,6	1360,2	1425,1	7
8	732,5	794,0	855,7	917,7	980,0	1042,6	1105,6	1168,9	1232,6	1296,7	1361,2	1426,2	8
9	733,5	795,0	856,7	918,8	981,1	1043,7	1106,6	1170,0	1233,6	1297,8	1362,3	1427,3	9
10	734,5	796,0	857,8	919,8	982,1	1044,7	1107,7	1171,0	1234,7	1298,8	1363,4	1428,4	10
11	735,5	797,0	858,8	920,8	983,1	1045,8	1108,7	1172,1	1235,8	1299,9	1364,5	1429,5	11
12	736,6	798,1	859,9	921,9	984,2	1046,8	1109,8	1173,1	1236,8	1301,0	1365,6	1430,6	12
13	737,6	799,1	861,0	922,9	985,2	1047,9	1110,8	1174,2	1237,9	1302,0	1366,6	1431,7	13
14	738,6	800,2	862,0	923,9	986,3	1048,9	1111,9	1175,2	1239,0	1303,1	1367,7	1432,8	14
15	739,6	801,2	863,0	925,0	987,3	1049,9	1112,9	1176,3	1240,0	1304,2	1368,8	1433,9	15
16	740,7	802,2	864,0	926,0	988,4	1051,0	1114,0	1177,4	1241,1	1305,3	1369,9	1434,9	16
17	741,7	803,2	865,0	927,0	989,4	1052,0	1115,0	1178,4	1242,2	1306,3	1370,9	1436,0	17
18	742,7	804,2	866,0	928,1	990,4	1053,1	1116,1	1179,5	1243,2	1307,4	1372,0	1437,1	18
19	743,7	805,3	867,1	929,1	991,5	1054,1	1117,1	1180,5	1244,3	1308,5	1373,1	1438,2	19
20	744,8	806,3	868,1	930,1	992,5	1055,2	1118,2	1181,6	1245,4	1309,6	1374,2	1439,3	20
21	745,8	807,3	869,1	931,2	993,6	1056,2	1119,2	1182,7	1246,4	1310,6	1375,3	1440,4	21
22	746,8	808,4	870,1	932,2	994,6	1057,3	1120,3	1183,7	1247,5	1311,7	1376,4	1441,5	22
23	747,8	809,4	871,2	933,2	995,6	1058,3	1121,3	1184,8	1248,6	1312,8	1377,4	1442,6	23
24	748,9	810,4	872,2	934,3	996,7	1059,4	1122,4	1185,8	1249,6	1313,8	1378,5	1443,7	24
25	749,9	811,4	873,2	935,3	997,7	1060,4	1123,4	1186,9	1250,7	1314,9	1379,6	1444,8	25
26	751,0	812,5	874,3	936,3	998,8	1061,4	1124,5	1188,0	1251,8	1316,0	1380,7	1445,8	26
27	752,0	813,5	875,3	937,4	999,8	1062,5	1125,5	1189,0	1252,8	1317,1	1381,8	1446,9	27
28	753,0	814,5	876,3	938,4	1000,8	1063,5	1126,6	1190,1	1253,9	1318,1	1382,8	1448,0	28
29	754,0	815,5	877,4	939,4	1001,9	1064,6	1127,6	1191,1	1255,0	1319,2	1383,9	1449,1	29
30	755,0	816,6	878,4	940,5	1002,9	1065,6	1128,7	1192,2	1256,0	1320,3	1385,0	1450,2	30
31	756,0	817,6	879,4	941,5	1004,0	1066,7	1129,7	1193,2	1257,1	1321,4	1386,1	1451,3	31
32	757,1	818,6	880,5	942,6	1005,0	1067,7	1130,8	1194,3	1258,2	1322,5	1387,2	1452,4	32
33	758,1	819,6	881,5	943,6	1006,1	1068,8	1131,8	1195,4	1259,2	1323,5	1388,3	1453,5	33
34	759,1	820,7	882,5	944,6	1007,1	1069,8	1132,9	1196,4	1260,3	1324,6	1389,4	1454,6	34
35	760,1	821,7	883,6	945,6	1008,1	1070,9	1134,0	1197,5	1261,4	1325,7	1390,4	1455,6	35
36	761,1	822,7	884,6	946,7	1009,2	1072,0	1135,1	1198,5	1262,4	1326,7	1391,5	1456,7	36
37	762,2	823,8	885,6	947,7	1010,2	1073,0	1136,1	1199,6	1263,5	1327,8	1392,6	1457,8	37
38	763,2	824,8	886,7	948,7	1011,3	1074,1	1137,2	1200,7	1264,6	1328,9	1393,7	1458,9	38
39	764,2	825,8	887,7	949,8	1012,3	1075,1	1138,2	1201,7	1265,6	1330,0	1394,8	1460,0	39
40	765,2	826,8	888,7	950,8	1013,4	1076,2	1139,3	1202,8	1266,7	1331,0	1395,8	1461,1	40
41	766,3	827,9	889,8	951,9	1014,4	1077,2	1140,3	1203,9	1267,8	1332,1	1396,9	1462,2	41
42	767,3	828,9	890,8	952,9	1015,4	1078,3	1141,4	1204,9	1268,8	1333,2	1398,2	1463,3	42
43	768,3	829,9	891,8	953,9	1016,5	1079,3	1142,4	1206,0	1269,9	1334,3	1399,3	1464,4	43
44	769,3	831,0	892,9	955,0	1017,5	1080,4	1143,5	1207,1	1271,0	1335,3	1400,3	1465,5	44
45	770,4	832,0	893,9	956,0	1018,6	1081,4	1144,6	1208,1	1272,1	1336,4	1401,4	1466,6	45
46	771,4	833,0	894,9	957,1	1019,6	1082,5	1145,6	1209,2	1273,1	1337,5	1402,5	1467,7	46
47	772,4	834,1	896,0	958,1	1020,6	1083,5	1146,7	1210,2	1274,2	1338,6	1403,6	1468,8	47
48	773,4	835,1	897,0	959,2	1021,7	1084,6	1147,7	1211,3	1275,3	1339,7	1405,7	1469,8	48
49	774,5	836,1	898,0	960,2	1022,7	1085,6	1148,8	1212,4	1276,3	1340,7	1406,7	1470,9	49
50	775,5	837,2	899,1	961,3	1023,8	1086,7	1149,8	1213,4	1277,4	1341,8	1407,8	1472,0	50
51	776,5	838,2	900,1	962,3	1024,8	1087,7	1150,9	1214,5	1278,5	1342,9	1408,9	1473,1	51
52	777,5	839,2	901,1	963,4	1025,8	1088,8	1152,0	1215,5	1279,5	1344,0	1408,8	1474,2	52
53	778,6	840,2	902,2	964,4	1026,8	1089,8	1153,0	1216,6	1280,6	1345,1	1409,9	1475,3	53
54	779,6	841,3	903,2	965,5	1028,0	1090,9	1154,1	1217,7	1281,7	1346,1	1411,0	1476,4	54
55	780,6	842,3	904,3	966,5	1029,0	1091,9	1155,1	1218,7	1282,8	1347,2	1412,1	1477,5	55
56	781,7	843,4	905,3	967,6	1030,0	1093,0	1156,2	1219,8	1283,8	1348,3	1413,2	1478,6	56
57	782,7	844,4	906,3	968,6	1031,0	1094,0	1157,2	1220,9	1284,9	1349,4	1414,3	1479,7	57
58	783,7	845,4	907,4	969,6	1032,1	1095,1	1158,3	1221,9	1286,0	1350,4	1415,4	1480,8	58
59	784,7	846,5	908,4	970,7	1033,1	1096,1	1159,4	1223,0	1287,0	1351,5	1416,5	1481,9	59
60	785,8	847,5	909,4	971,7	1034,2	1097,2	1160,4	1224,1	1288,1	1352,6	1417,6	1483,0	60
D.1.	12	13	14	15	16	17	18	19	20	21	22	23	D.1.

MERIDIONAL PARTS.

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D. 1.	24	25	26	27	28	29	30	31	32	33	34	35	D. 1.
1	1484,1	1550,0	1616,5	1683,5	1751,2	1819,5	1888,4	1958,0	2028,4	2099,6	2171,5	2244,3	1
2	1485,2	1551,1	1617,6	1684,6	1752,3	1820,6	1889,5	1959,2	2029,6	2100,7	2172,7	2245,5	2
3	1486,3	1552,2	1618,7	1685,8	1753,4	1821,7	1890,7	1960,4	2030,7	2101,9	2173,9	2246,8	3
4	1487,3	1553,3	1619,8	1686,9	1754,6	1822,9	1891,9	1961,6	2031,9	2103,1	2175,1	2248,0	4
5	1488,4	1554,4	1620,9	1688,0	1755,7	1824,0	1893,0	1962,7	2033,1	2104,3	2176,3	2249,2	5
6	1489,5	1555,5	1622,0	1689,1	1756,8	1825,2	1894,1	1963,9	2034,3	2105,5	2177,5	2250,4	6
7	1490,6	1556,6	1623,2	1690,3	1758,0	1826,3	1895,3	1965,0	2035,5	2106,7	2178,7	2251,6	7
8	1491,7	1557,7	1624,3	1691,4	1759,1	1827,5	1896,5	1966,2	2036,7	2107,9	2180,0	2252,9	8
9	1492,8	1558,8	1625,4	1692,5	1760,2	1828,6	1897,6	1967,4	2037,8	2109,1	2181,2	2254,1	9
10	1493,9	1559,9	1626,5	1693,6	1761,4	1829,7	1898,8	1968,5	2039,0	2110,3	2182,4	2255,3	10
11	1495,0	1561,0	1627,6	1694,8	1762,5	1830,9	1899,9	1969,7	2040,2	2111,5	2183,6	2256,5	11
12	1496,1	1562,1	1628,7	1695,9	1763,6	1832,0	1901,1	1970,9	2041,4	2112,7	2184,8	2257,8	12
13	1497,2	1563,2	1629,8	1697,0	1764,8	1833,2	1902,3	1972,0	2042,6	2113,9	2186,0	2259,0	13
14	1498,3	1564,3	1631,0	1698,1	1765,9	1834,3	1903,4	1973,2	2043,8	2115,1	2187,2	2260,2	14
15	1499,4	1565,4	1632,1	1699,3	1767,0	1835,5	1904,6	1974,4	2044,9	2116,3	2188,4	2261,4	15
16	1500,5	1566,5	1633,2	1700,4	1768,2	1836,6	1905,7	1975,6	2046,1	2117,5	2189,6	2262,7	16
17	1501,6	1567,6	1634,3	1701,5	1769,3	1837,8	1906,9	1976,8	2047,3	2118,7	2190,8	2263,9	17
18	1502,7	1568,7	1635,4	1702,6	1770,5	1838,9	1908,1	1977,9	2048,5	2119,8	2192,0	2265,1	18
19	1503,8	1569,8	1636,5	1703,8	1771,6	1840,1	1909,2	1979,1	2049,7	2121,0	2193,3	2266,3	19
20	1504,9	1571,0	1637,7	1704,9	1772,7	1841,2	1910,4	1980,3	2050,8	2122,2	2194,4	2267,6	20
21	1506,0	1572,1	1638,8	1706,0	1773,9	1842,4	1911,5	1981,4	2052,0	2123,4	2195,7	2268,8	21
22	1507,1	1573,2	1639,9	1707,1	1775,0	1843,5	1912,7	1982,6	2053,2	2124,6	2196,9	2270,0	22
23	1508,2	1574,3	1641,0	1708,3	1776,1	1844,6	1913,8	1983,7	2054,4	2125,8	2198,1	2271,2	23
24	1509,3	1575,4	1642,1	1709,4	1777,2	1845,8	1915,0	1984,9	2055,6	2127,0	2199,3	2272,5	24
25	1510,4	1576,5	1643,2	1710,5	1778,4	1846,9	1916,2	1986,1	2056,8	2128,2	2200,5	2273,7	25
26	1511,5	1577,6	1644,3	1711,6	1779,5	1848,1	1917,3	1987,3	2058,0	2129,4	2201,7	2274,9	26
27	1512,6	1578,7	1645,5	1712,8	1780,6	1849,2	1918,5	1988,4	2059,1	2130,6	2203,0	2276,1	27
28	1513,7	1579,8	1646,6	1713,9	1781,8	1850,4	1919,6	1989,6	2060,3	2131,8	2204,2	2277,4	28
29	1514,8	1580,9	1647,7	1715,0	1783,0	1851,5	1920,8	1990,8	2061,5	2133,0	2205,4	2278,6	29
30	1515,9	1582,0	1648,8	1716,1	1784,1	1852,7	1921,9	1992,0	2062,7	2134,2	2206,6	2279,8	30
31	1517,0	1583,2	1649,9	1717,2	1785,2	1853,8	1923,1	1993,1	2063,9	2135,4	2207,8	2281,0	31
32	1518,1	1584,3	1651,0	1718,4	1786,4	1855,0	1924,3	1994,3	2065,1	2136,6	2209,0	2282,3	32
33	1519,2	1585,4	1652,2	1719,5	1787,5	1856,1	1925,4	1995,5	2066,2	2137,8	2210,2	2283,5	33
34	1520,3	1586,5	1653,3	1720,7	1788,6	1857,2	1926,6	1996,6	2067,4	2139,0	2211,4	2284,7	34
35	1521,4	1587,6	1654,4	1721,8	1789,8	1858,4	1927,8	1997,8	2068,6	2140,2	2212,7	2286,0	35
36	1522,5	1588,7	1655,5	1722,9	1790,9	1859,6	1928,9	1999,0	2069,8	2141,4	2213,9	2287,2	36
37	1523,6	1589,8	1656,6	1724,0	1792,1	1860,7	1930,1	2000,2	2071,0	2142,6	2215,1	2288,4	37
38	1524,7	1590,9	1657,8	1725,2	1793,2	1861,9	1931,3	2001,3	2072,2	2143,8	2216,3	2289,7	38
39	1525,8	1592,0	1658,9	1726,3	1794,3	1863,0	1932,4	2002,5	2073,4	2145,0	2217,5	2290,9	39
40	1526,9	1593,2	1660,0	1727,4	1795,5	1864,2	1933,6	2003,7	2074,6	2146,2	2218,7	2292,1	40
41	1528,0	1594,3	1661,1	1728,6	1796,6	1865,3	1934,7	2004,9	2075,7	2147,4	2219,9	2293,3	41
42	1529,1	1595,4	1662,2	1729,7	1797,8	1866,5	1935,9	2006,0	2076,9	2148,6	2221,2	2294,6	42
43	1530,2	1596,5	1663,4	1730,8	1798,9	1867,6	1937,1	2007,2	2078,1	2149,8	2222,4	2295,8	43
44	1531,3	1597,6	1664,5	1731,9	1800,0	1868,8	1938,2	2008,4	2079,3	2151,0	2223,6	2297,0	44
45	1532,4	1598,7	1665,6	1733,1	1801,2	1869,9	1939,4	2009,6	2080,5	2152,2	2224,8	2298,3	45
46	1533,5	1599,8	1666,7	1734,2	1802,3	1871,1	1940,5	2010,7	2081,7	2153,4	2226,0	2299,5	46
47	1534,6	1600,9	1667,8	1735,3	1803,5	1872,2	1941,7	2011,9	2082,9	2154,6	2227,2	2300,7	47
48	1535,7	1602,0	1669,0	1736,3	1804,6	1873,4	1942,9	2013,1	2084,1	2155,8	2228,5	2302,0	48
49	1536,8	1603,1	1670,1	1737,6	1805,7	1874,5	1944,0	2014,3	2085,3	2157,0	2229,7	2303,2	49
50	1537,9	1604,3	1671,2	1738,7	1806,9	1875,7	1945,2	2015,4	2086,8	2158,2	2330,9	2304,4	50
51	1539,0	1605,4	1672,3	1739,9	1808,0	1876,8	1946,4	2016,6	2087,7	2159,4	2232,1	2305,7	51
52	1540,1	1606,5	1673,4	1741,0	1809,2	1878,0	1947,5	2017,8	2088,9	2160,7	2233,3	2306,9	52
53	1541,2	1607,6	1674,5	1742,1	1810,3	1879,2	1948,7	2019,0	2090,1	2161,9	2234,8	2308,1	53
54	1542,3	1608,7	1675,7	1743,2	1811,4	1880,3	1949,9	2020,2	2091,3	2163,1	2235,8	2309,4	54
55	1543,4	1609,8	1676,8	1744,4	1812,6	1881,5	1951,0	2021,3	2092,5	2164,3	2237,0	2310,6	55
56	1544,5	1610,9	1678,0	1745,5	1813,7	1882,6	1952,2	2022,5	2093,7	2165,5	2238,2	2311,8	56
57	1545,6	1612,0	1679,1	1746,6	1814,9	1883,8	1953,4	2023,7	2094,9	2166,7	2239,4	2313,1	57
58	1546,7	1613,1	1680,2	1747,8	1816,0	1884,9	1954,5	2024,9	2096,1	2167,9	2240,7	2314,3	58
59	1547,8	1614,2	1681,3	1748,9	1817,2	1886,1	1955,7	2026,0	2097,3	2169,1	2241,9	2315,5	59
60	1548,9	1615,4	1682,4	1750,0	1818,3	1887,2	1956,9	2027,2	2098,5	2170,3	2243,1	2316,7	60
D. 1.	24	25	26	27	28	29	30	31	32	33	34	35	D. 1.

D. I.	36	37	38	39	40	41	42	43	44	45	46	47	D. I.
1	2318,0	2392,7	2468,3	2545,0	2622,7	2701,6	2781,7	2863,1	2945,7	3030,0	3115,6	3202,8	1
2	2319,3	2393,9	2469,6	2546,2	2624,0	2702,9	2783,1	2864,5	2947,2	3031,4	3117,0	3204,2	2
3	2320,5	2395,2	2470,8	2547,5	2625,3	2704,3	2784,4	2865,8	2948,6	3032,8	3118,5	3205,7	3
4	2321,7	2396,4	2472,1	2548,8	2626,6	2705,6	2785,8	2867,2	2950,0	3034,2	3119,9	3207,2	4
5	2323,0	2397,7	2473,4	2550,1	2627,9	2706,9	2787,1	2868,6	2951,4	3035,6	3121,4	3208,6	5
6	2324,2	2398,9	2474,6	2551,4	2629,2	2708,3	2788,5	2870,0	2952,8	3037,0	3122,8	3210,1	6
7	2325,4	2400,2	2475,9	2552,7	2630,5	2709,6	2789,8	2871,3	2954,2	3038,4	3124,2	3211,6	7
8	2326,7	2401,4	2477,1	2554,0	2631,9	2710,9	2791,2	2872,7	2955,6	3039,8	3125,7	3213,0	8
9	2327,9	2402,7	2478,5	2555,3	2633,2	2712,2	2792,5	2874,1	2957,0	3041,3	3127,1	3214,5	9
10	2329,2	2403,9	2479,7	2556,6	2634,5	2713,6	2793,8	2875,4	2958,4	3042,7	3128,6	3216,0	10
11	2330,4	2405,2	2481,0	2557,8	2635,8	2714,9	2795,1	2876,8	2959,8	3044,1	3130,0	3217,4	11
12	2331,6	2406,4	2482,3	2559,1	2637,1	2716,2	2796,5	2878,2	2961,1	3045,5	3131,5	3218,9	12
13	2332,9	2407,7	2483,5	2560,4	2638,4	2717,5	2797,9	2879,5	2962,5	3047,0	3132,9	3220,4	13
14	2334,1	2409,0	2484,8	2561,7	2639,7	2718,9	2799,3	2880,9	2963,9	3048,4	3134,3	3221,9	14
15	2335,3	2410,2	2486,1	2563,0	2641,0	2720,2	2800,6	2882,3	2965,3	3049,8	3135,8	3223,3	15
16	2336,6	2411,5	2487,4	2564,3	2642,3	2721,5	2802,0	2883,7	2966,7	3051,2	3137,2	3224,8	16
17	2337,8	2412,7	2488,6	2565,6	2643,6	2722,9	2803,3	2885,0	2968,1	3052,6	3138,7	3226,3	17
18	2339,0	2414,0	2489,9	2566,9	2644,9	2724,2	2804,7	2886,4	2969,5	3054,1	3140,1	3227,7	18
19	2340,3	2415,2	2491,2	2568,2	2646,3	2725,5	2806,0	2887,8	2970,9	3055,5	3141,6	3229,2	19
20	2341,5	2416,5	2492,5	2569,5	2647,6	2726,9	2807,4	2889,2	2972,3	3056,9	3143,0	3230,7	20
21	2342,8	2417,8	2493,7	2570,7	2648,9	2728,2	2808,8	2890,5	2973,7	3058,3	3144,5	3232,2	21
22	2344,0	2419,0	2495,0	2572,0	2650,2	2729,5	2810,1	2891,9	2975,1	3059,7	3145,9	3233,6	22
23	2345,3	2420,3	2496,3	2573,3	2651,5	2730,8	2811,4	2893,3	2976,5	3061,2	3147,4	3235,1	23
24	2346,5	2421,5	2497,6	2574,6	2652,8	2732,2	2812,8	2894,7	2977,9	3062,6	3148,8	3236,6	24
25	2347,8	2422,8	2498,8	2575,9	2654,1	2733,5	2814,1	2896,0	2979,3	3064,0	3150,3	3238,1	25
26	2349,0	2424,0	2500,1	2577,2	2655,5	2734,8	2815,5	2897,4	2980,7	3065,4	3151,7	3239,5	26
27	2350,2	2425,3	2501,4	2578,5	2656,8	2736,2	2816,8	2898,8	2982,1	3066,9	3153,2	3241,0	27
28	2351,5	2426,5	2502,7	2579,8	2658,1	2737,5	2818,2	2900,2	2983,5	3068,3	3154,6	3242,5	28
29	2352,7	2427,8	2503,9	2581,1	2659,4	2738,8	2819,5	2901,5	2984,9	3069,7	3156,1	3244,0	29
30	2354,0	2429,1	2505,2	2582,4	2660,7	2740,2	2820,9	2902,9	2986,3	3071,1	3157,5	3245,5	30
31	2355,2	2430,3	2506,5	2583,7	2662,0	2741,5	2822,3	2904,3	2987,7	3072,6	3159,0	3246,9	31
32	2356,5	2431,6	2507,8	2585,0	2663,3	2742,9	2823,6	2905,7	2989,1	3074,0	3160,4	3248,4	32
33	2357,7	2432,9	2509,0	2586,3	2664,6	2744,2	2825,0	2907,1	2990,5	3075,4	3161,9	3249,9	33
34	2358,9	2434,1	2510,3	2587,6	2666,0	2745,5	2826,3	2908,4	2991,9	3076,9	3163,3	3251,4	34
35	2360,2	2435,4	2511,6	2588,9	2667,3	2746,9	2827,7	2909,7	2993,3	3078,3	3164,8	3252,9	35
36	2361,4	2436,7	2512,9	2590,2	2668,6	2748,2	2829,0	2911,2	2994,7	3079,7	3166,2	3254,4	36
37	2362,7	2437,9	2514,2	2591,5	2669,9	2749,5	2830,4	2912,6	2996,1	3081,1	3167,7	3255,8	37
38	2363,9	2439,2	2515,4	2592,8	2671,2	2750,9	2831,8	2914,0	2997,5	3082,6	3169,1	3257,3	38
39	2365,2	2440,4	2516,7	2594,1	2672,5	2752,2	2833,1	2915,3	2998,9	3084,0	3170,6	3258,8	39
40	2366,4	2441,7	2518,0	2595,4	2673,9	2753,5	2834,5	2916,7	3000,3	3085,4	3172,1	3260,3	40
41	2367,7	2443,0	2519,3	2596,7	2675,1	2754,9	2835,8	2918,1	3001,8	3086,9	3173,5	3261,8	41
42	2368,9	2444,2	2520,6	2598,0	2676,5	2756,2	2837,2	2919,5	3003,2	3088,3	3175,0	3263,3	42
43	2370,2	2445,5	2521,8	2599,3	2677,8	2757,6	2838,6	2920,9	3004,6	3089,7	3176,4	3264,7	43
44	2371,4	2446,8	2523,1	2600,6	2679,1	2758,9	2839,9	2922,3	3006,0	3091,2	3177,9	3266,2	44
45	2372,7	2448,0	2524,4	2601,9	2680,5	2760,2	2841,3	2923,6	3007,4	3092,6	3179,3	3267,7	45
46	2373,9	2449,3	2525,7	2603,2	2681,8	2761,5	2842,6	2925,0	3008,8	3094,0	3180,8	3269,2	46
47	2375,2	2450,6	2527,0	2604,5	2683,1	2762,9	2844,0	2926,4	3010,2	3095,5	3182,3	3270,7	47
48	2376,4	2451,8	2528,3	2605,8	2684,4	2764,3	2845,4	2927,8	3011,6	3096,9	3183,7	3272,2	48
49	2377,7	2453,1	2529,5	2607,1	2685,7	2765,6	2846,7	2929,2	3013,0	3098,3	3185,1	3273,7	49
50	2378,9	2454,3	2530,8	2608,4	2687,1	2766,9	2848,1	2930,6	3014,4	3099,8	3186,6	3275,2	50
51	2380,1	2455,6	2532,1	2609,7	2688,4	2768,3	2849,5	2932,0	3015,8	3101,2	3188,1	3276,6	51
52	2381,4	2456,9	2533,4	2611,0	2689,7	2769,6	2850,8	2933,3	3017,2	3102,6	3189,6	3278,1	52
53	2382,6	2458,1	2534,7	2612,3	2691,0	2771,0	2852,2	2934,7	3018,7	3104,1	3191,0	3279,6	53
54	2383,9	2459,4	2536,0	2613,6	2692,3	2772,3	2853,6	2936,1	3020,1	3105,6	3192,5	3281,1	54
55	2385,1	2460,7	2537,2	2614,9	2693,7	2773,7	2854,9	2937,5	3021,5	3107,0	3194,0	3282,6	55
56	2386,4	2461,9	2538,5	2616,2	2695,0	2775,0	2856,3	2938,9	3022,9	3108,4	3195,4	3284,1	56
57	2387,6	2463,2	2539,8	2617,5	2696,3	2776,4	2857,6	2940,3	3024,3	3109,8	3196,9	3285,6	57
58	2388,9	2464,5	2541,1	2618,8	2697,6	2777,7	2859,1	2941,7	3025,7	3111,2	3198,4	3287,1	58
59	2390,2	2465,8	2542,4	2620,1	2699,0	2779,0	2860,5	2943,1	3027,1	3112,7	3199,8	3288,6	59
60	2391,4	2467,0	2543,7	2621,4	2700,3	2780,4	2861,8	2944,4	3028,5	3114,1	3201,3	3290,1	60
D. I.	36	37	38	39	40	41	42	43	44	45	46	47	D. I.

MERIDIONAL PARTS.

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D. 1.	48	49	50	51	52	53	54	55	56	57	58	59	D. 1.
1	3291,6	3382,1	3474,5	3568,8	3665,2	3763,8	3864,7	3968,0	4073,9	4182,6	4294,3	4409,2	1
2	3293,1	3383,6	3476,1	3570,4	3666,9	3765,5	3866,4	3969,7	4075,7	4184,5	4296,2	4411,1	2
3	3294,6	3385,2	3477,6	3572,0	3668,5	3767,1	3868,1	3971,5	4077,5	4186,3	4298,1	4413,1	3
4	3296,1	3386,7	3479,2	3573,6	3670,1	3768,8	3869,8	3973,2	4079,3	4188,2	4300,0	4415,0	4
5	3297,5	3388,2	3480,7	3575,2	3671,7	3770,4	3871,5	3975,0	4081,1	4190,0	4302,9	4417,0	5
6	3299,0	3389,7	3482,3	3576,8	3673,4	3772,1	3873,2	3976,7	4082,9	4191,8	4303,8	4418,9	6
7	3300,5	3391,3	3483,9	3578,4	3675,0	3773,8	3874,9	3978,4	4084,7	4193,7	4305,7	4420,8	7
8	3302,0	3392,8	3485,4	3580,0	3676,6	3775,4	3876,6	3980,2	4086,5	4195,5	4307,6	4422,8	8
9	3303,5	3394,3	3487,0	3581,6	3678,2	3777,1	3878,3	3982,0	4088,3	4198,4	4309,5	4424,7	9
10	3305,0	3395,9	3488,5	3583,2	3679,9	3778,8	3880,0	3983,7	4090,1	4199,2	4311,4	4426,7	10
11	3306,5	3397,4	3490,1	3584,8	3681,5	3780,4	3881,7	3985,5	4091,9	4201,1	4313,2	4428,6	11
12	3308,0	3398,9	3491,7	3586,4	3683,1	3782,1	3883,4	3987,2	4093,7	4202,9	4315,1	4430,6	12
13	3309,5	3400,4	3493,2	3588,0	3684,8	3783,8	3885,1	3989,0	4095,5	4204,7	4317,0	4432,5	13
14	3311,0	3402,0	3494,8	3589,5	3686,4	3785,5	3886,8	3990,7	4097,3	4206,6	4318,9	4434,5	14
15	3312,5	3403,5	3496,3	3591,1	3688,0	3787,1	3888,6	3992,5	4099,1	4208,4	4320,8	4436,4	15
16	3314,0	3405,0	3497,9	3592,7	3689,7	3788,8	3890,3	3994,2	4100,9	4210,3	4322,7	4438,4	16
17	3315,5	3406,6	3499,5	3594,3	3691,3	3790,5	3892,0	3996,0	4102,7	4212,1	4324,6	4440,4	17
18	3317,0	3408,1	3501,0	3595,9	3692,9	3792,1	3893,7	3997,7	4104,5	4214,0	4326,5	4442,3	18
19	3318,5	3409,6	3502,6	3597,5	3694,6	3793,8	3895,4	3999,5	4106,3	4215,8	4328,4	4444,3	19
20	3320,0	3411,2	3504,2	3599,1	3696,2	3795,5	3897,1	4001,3	4108,1	4217,7	4330,3	4446,2	20
21	3321,5	3412,7	3505,7	3600,7	3697,8	3797,2	3898,8	4003,0	4109,9	4219,5	4332,2	4448,2	21
22	3323,1	3414,2	3507,3	3602,3	3699,5	3798,8	3900,5	4004,8	4111,7	4221,4	4334,2	4450,2	22
23	3324,6	3415,8	3508,9	3603,9	3701,1	3800,5	3902,3	4006,5	4113,5	4223,2	4336,1	4452,1	23
24	3326,1	3417,3	3510,5	3605,5	3702,7	3802,2	3904,0	4008,3	4115,3	4225,1	4338,0	4454,1	24
25	3327,6	3418,8	3512,0	3607,1	3704,4	3803,9	3905,7	4010,0	4117,1	4227,0	4339,9	4456,0	25
26	3329,1	3420,4	3513,6	3608,7	3706,0	3805,5	3907,4	4011,8	4118,9	4228,8	4341,8	4458,0	26
27	3330,6	3421,9	3515,1	3610,3	3707,7	3807,2	3909,1	4013,6	4120,7	4230,7	4343,7	4460,0	27
28	3332,1	3423,5	3516,7	3611,9	3709,3	3808,9	3910,9	4015,3	4122,5	4232,5	4345,6	4461,9	28
29	3333,6	3425,0	3518,3	3613,6	3710,9	3810,6	3912,6	4017,1	4124,3	4234,4	4347,5	4463,9	29
30	3335,1	3426,5	3519,8	3615,2	3712,6	3812,3	3914,3	4018,9	4126,1	4236,2	4349,4	4465,9	30
31	3336,6	3428,1	3521,4	3616,8	3714,2	3813,9	3916,0	4020,6	4127,9	4238,1	4351,3	4467,8	31
32	3338,1	3429,6	3523,0	3618,4	3715,9	3815,6	3917,7	4022,4	4129,7	4240,0	4353,3	4469,8	32
33	3339,6	3431,2	3524,6	3620,0	3717,5	3817,3	3919,5	4024,2	4131,6	4241,8	4355,2	4471,8	33
34	3341,1	3432,7	3526,1	3621,6	3719,2	3819,0	3921,2	4025,9	4133,4	4243,7	4357,1	4473,8	34
35	3342,7	3434,2	3527,7	3623,2	3720,8	3820,7	3922,9	4027,7	4135,2	4245,6	4359,0	4475,7	35
36	3344,2	3435,8	3529,3	3624,8	3722,4	3822,3	3924,6	4029,5	4137,0	4247,4	4360,9	4477,7	36
37	3345,7	3437,3	3530,9	3626,4	3724,1	3824,0	3926,4	4031,2	4139,8	4249,3	4362,8	4479,7	37
38	3347,2	3438,9	3532,4	3628,0	3725,7	3825,7	3928,1	4033,0	4141,6	4251,2	4364,8	4481,7	38
39	3348,7	3440,4	3534,0	3629,6	3727,4	3827,4	3929,8	4034,8	4143,5	4253,0	4366,7	4483,6	39
40	3350,1	3442,0	3535,6	3631,3	3729,0	3829,1	3931,5	4036,6	4144,3	4254,9	4368,6	4485,6	40
41	3351,7	3443,5	3537,2	3632,9	3730,7	3830,8	3933,3	4038,3	4146,1	4256,8	4370,5	4487,6	41
42	3353,2	3445,0	3538,8	3634,5	3732,3	3832,5	3935,0	4040,1	4147,9	4258,6	4372,5	4489,6	42
43	3354,8	3446,6	3540,3	3636,1	3734,0	3834,2	3936,7	4041,9	4149,7	4260,5	4374,4	4491,6	43
44	3356,3	3448,1	3541,9	3637,7	3735,6	3835,8	3938,5	4043,6	4151,6	4262,4	4376,3	4493,5	44
45	3357,8	3449,7	3543,5	3639,3	3737,3	3837,5	3940,2	4045,4	4153,4	4264,3	4378,2	4495,5	45
46	3359,3	3451,2	3545,1	3640,9	3738,9	3839,2	3941,9	4047,2	4155,2	4266,1	4380,2	4497,5	46
47	3360,8	3452,8	3546,7	3642,5	3740,6	3840,9	3943,7	4049,0	4157,0	4268,0	4382,1	4499,5	47
48	3362,3	3454,3	3548,2	3644,2	3742,2	3842,6	3945,4	4050,8	4158,8	4269,9	4384,0	4501,5	48
49	3363,9	3455,9	3549,8	3645,8	3743,9	3844,3	3947,1	4052,5	4160,7	4271,8	4385,9	4503,5	49
50	3365,4	3457,4	3551,4	3647,4	3745,6	3846,0	3948,9	4054,3	4162,5	4273,6	4387,9	4505,5	50
51	3366,9	3459,0	3553,0	3649,0	3747,2	3847,7	3950,6	4056,1	4164,3	4275,5	4389,8	4507,5	51
52	3368,4	3460,5	3554,6	3650,6	3748,9	3849,4	3952,3	4057,9	4166,2	4277,4	4391,7	4509,4	52
53	3369,9	3462,1	3556,1	3652,3	3750,5	3851,1	3954,1	4059,7	4168,0	4279,3	4393,7	4511,4	53
54	3371,5	3463,6	3557,7	3653,9	3752,2	3852,8	3955,8	4061,4	4169,8	4281,1	4395,6	4513,4	54
55	3373,0	3465,1	3559,3	3655,5	3753,8	3854,5	3957,6	4063,2	4171,7	4283,0	4397,5	4515,4	55
56	3374,5	3466,7	3560,9	3657,1	3755,5	3856,2	3959,3	4065,0	4173,5	4284,9	4399,5	4517,4	56
57	3376,0	3468,3	3562,5	3658,7	3757,2	3857,9	3961,0	4066,8	4175,3	4286,8	4401,4	4519,4	57
58	3377,6	3469,8	3564,1	3660,4	3758,8	3859,6	3962,8	4068,6	4177,2	4288,7	4403,4	4521,4	58
59	3379,1	3471,4	3565,7	3662,0	3760,5	3861,3	3964,5	4070,4	4179,0	4290,6	4405,3	4523,4	59
60	3380,6	3473,0	3567,3	3663,6	3762,2	3863,0	3966,3	4072,1	4180,8	4292,5	4407,2	4525,4	60

D. 1.	60	61	62	63	64	65	66	67	68	69	70	71	D. 1.
1	4527.4	4649.2	4775.0	4905.0	5039.4	5178.8	5323.6	5474.0	5630.9	5794.0	5960.0	6145.7	1
2	4529.4	4651.3	4777.1	4907.2	5041.7	5181.2	5326.0	5476.6	5633.5	5797.4	5968.9	6148.8	2
3	4531.4	4653.4	4779.3	4909.4	5044.0	5183.6	5328.5	5479.2	5636.2	5800.2	5971.8	6151.9	3
4	4533.4	4655.5	4781.4	4911.6	5046.3	5186.0	5330.9	5481.7	5638.9	5803.0	5974.7	6155.0	4
5	4535.4	4657.5	4783.5	4913.8	5048.6	5188.3	5333.4	5484.3	5641.5	5805.8	5977.7	6158.0	5
6	4537.4	4659.6	4785.7	4916.0	5050.8	5190.7	5335.9	5486.9	5644.2	5808.6	5980.6	6161.1	6
7	4539.4	4661.7	4787.8	4918.2	5053.2	5193.1	5338.3	5489.4	5646.9	5811.4	5983.5	6164.2	7
8	4541.4	4663.7	4790.0	4920.4	5055.5	5195.4	5340.8	5492.0	5649.6	5814.2	5986.5	6167.3	8
9	4543.4	4665.8	4792.1	4922.6	5057.7	5197.8	5343.3	5494.6	5652.3	5817.0	5989.4	6170.4	9
10	4545.4	4667.9	4794.2	4924.8	5060.0	5200.2	5345.7	5497.1	5655.0	5819.8	5992.4	6173.5	10
11	4547.5	4669.9	4796.4	4927.1	5062.3	5202.6	5348.2	5499.7	5657.6	5822.6	5995.3	6176.6	11
12	4549.5	4672.0	4798.5	4929.3	5064.6	5205.0	5350.7	5502.3	5660.3	5825.4	5998.3	6179.7	12
13	4551.5	4674.1	4800.7	4931.5	5066.9	5207.3	5353.2	5504.9	5663.0	5828.2	6001.2	6182.8	13
14	4553.5	4676.2	4802.8	4933.7	5069.2	5209.7	5355.6	5507.4	5665.7	5831.0	6004.2	6185.9	14
15	4555.5	4678.2	4804.9	4935.9	5071.5	5212.1	5358.1	5510.0	5668.4	5833.9	6007.1	6189.0	15
16	4557.5	4680.3	4807.1	4938.1	5073.8	5214.5	5360.6	5512.6	5671.1	5836.7	6010.1	6192.1	16
17	4559.5	4682.4	4809.2	4940.4	5076.1	5216.9	5363.1	5515.2	5673.8	5839.5	6013.0	6195.2	17
18	4561.5	4684.5	4811.4	4942.6	5078.4	5219.3	5365.6	5517.8	5676.5	5842.3	6016.0	6198.3	18
19	4563.6	4686.6	4813.5	4944.8	5080.7	5221.7	5368.1	5520.4	5679.2	5845.2	6019.0	6201.4	19
20	4565.6	4688.6	4815.7	4947.0	5083.0	5224.1	5370.5	5523.0	5681.9	5848.0	6021.9	6204.6	20
21	4567.6	4690.7	4817.8	4949.3	5085.3	5226.5	5373.0	5525.6	5684.6	5850.8	6024.9	6207.7	21
22	4569.6	4692.8	4820.0	4951.5	5087.7	5228.9	5375.5	5528.2	5687.3	5853.7	6027.9	6210.8	22
23	4571.6	4694.9	4822.2	4953.7	5090.0	5231.3	5378.0	5530.8	5690.0	5856.5	6030.8	6213.9	23
24	4573.7	4697.0	4824.3	4956.0	5092.3	5233.7	5380.5	5533.4	5692.8	5859.3	6033.8	6217.1	24
25	4575.7	4699.1	4826.5	4958.2	5094.6	5236.1	5383.0	5536.0	5695.5	5862.2	6036.8	6220.2	25
26	4577.7	4701.2	4828.6	4960.7	5096.9	5238.5	5385.5	5538.6	5698.2	5865.0	6039.8	6223.3	26
27	4579.7	4703.2	4830.8	4962.4	5099.2	5240.9	5388.0	5541.2	5700.9	5867.9	6042.7	6226.5	27
28	4581.8	4705.3	4832.9	4964.9	5101.5	5243.3	5390.5	5543.8	5703.6	5870.7	6045.7	6229.6	28
29	4583.8	4707.4	4835.1	4967.1	5103.9	5245.7	5393.0	5546.4	5706.3	5873.5	6048.7	6232.7	29
30	4585.8	4709.5	4837.3	4969.4	5106.2	5248.1	5395.5	5549.0	5709.1	5876.4	6051.7	6235.9	30
31	4587.8	4711.6	4839.4	4971.6	5108.5	5250.5	5398.0	5551.6	5711.8	5879.3	6054.7	6239.0	31
32	4589.9	4713.7	4841.6	4972.9	5110.8	5252.9	5400.5	5554.2	5714.5	5882.1	6057.7	6242.2	32
33	4591.9	4715.8	4843.8	4976.1	5113.1	5255.3	5403.0	5556.8	5717.3	5885.0	6060.7	6245.3	33
34	4593.9	4717.9	4845.9	4978.3	5115.5	5257.7	5405.6	5559.5	5720.0	5887.8	6063.7	6248.5	34
35	4596.0	4720.0	4848.1	4980.6	5117.8	5260.1	5408.1	5562.1	5722.7	5890.7	6066.7	6251.7	35
36	4598.0	4722.1	4850.3	4982.8	5120.1	5262.6	5410.6	5564.7	5725.5	5893.6	6069.7	6254.8	36
37	4600.1	4724.2	4852.5	4985.1	5122.5	5265.0	5413.1	5567.3	5728.2	5896.4	6072.7	6258.0	37
38	4602.1	4726.3	4854.6	4987.3	5124.8	5267.4	5415.6	5569.9	5731.0	5899.3	6075.7	6261.2	38
39	4604.1	4728.4	4856.8	4989.6	5127.1	5269.8	5418.1	5572.6	5733.7	5902.2	6078.8	6264.4	39
40	4606.2	4730.5	4859.0	4991.8	5129.5	5272.3	5420.7	5575.2	5736.4	5905.1	6081.8	6267.5	40
41	4608.2	4732.6	4861.2	4994.1	5131.8	5274.7	5423.2	5577.8	5739.2	5907.9	6084.8	6270.7	41
42	4610.3	4734.7	4863.3	4996.3	5134.1	5277.1	5425.7	5580.5	5741.9	5910.8	6087.8	6273.9	42
43	4612.3	4736.9	4865.5	4998.6	5136.5	5279.5	5428.2	5583.1	5744.7	5913.7	6090.8	6277.1	43
44	4614.3	4739.0	4867.7	5000.9	5138.8	5282.0	5430.8	5585.7	5747.5	5916.6	6093.9	6280.3	44
45	4616.4	4741.1	4869.9	5003.1	5141.2	5284.4	5433.3	5588.4	5750.2	5919.5	6096.9	6283.5	45
46	4618.4	4743.2	4872.1	5005.5	5143.5	5286.8	5435.8	5591.0	5753.0	5922.4	6099.0	6286.6	46
47	4620.5	4745.3	4874.3	5007.6	5145.9	5289.3	5438.4	5593.7	5755.7	5925.2	6103.0	6289.8	47
48	4622.5	4747.4	4876.4	5009.9	5148.2	5291.7	5440.9	5596.3	5758.5	5928.1	6106.0	6293.0	48
49	4624.6	4749.5	4878.6	5012.2	5150.6	5294.2	5443.5	5599.0	5761.3	5931.0	6109.1	6296.2	49
50	4626.6	4751.7	4880.8	5014.4	5152.9	5296.6	5446.0	5601.6	5764.0	5933.9	6112.1	6299.4	50
51	4628.7	4753.8	4882.9	5016.6	5155.3	5299.0	5448.5	5604.3	5766.8	5936.8	6115.1	6302.7	51
52	4630.7	4755.9	4885.4	5019.0	5157.6	5301.5	5451.1	5606.9	5769.6	5939.7	6118.2	6305.9	52
53	4632.8	4758.0	4887.2	5021.2	5160.0	5303.9	5453.6	5609.6	5772.3	5942.6	6121.2	6309.1	53
54	4634.8	4760.1	4889.6	5023.5	5162.3	5306.4	5456.2	5612.2	5775.1	5945.5	6124.3	6312.3	54
55	4636.9	4762.3	4891.8	5025.8	5164.7	5308.8	5458.7	5614.9	5777.9	5948.5	6127.4	6315.5	55
56	4639.0	4764.4	4894.0	5028.1	5167.0	5311.3	5461.3	5617.5	5780.7	5951.4	6130.4	6318.7	56
57	4641.0	4766.5	4896.2	5030.3	5169.4	5313.7	5463.8	5620.2	5783.5	5954.3	6133.5	6322.0	57
58	4643.1	4768.6	4898.4	5032.6	5171.8	5316.2	5466.4	5622.9	5786.2	5957.2	6136.5	6325.2	58
59	4645.1	4770.8	4900.6	5034.9	5174.1	5318.6	5468.9	5625.5	5789.0	5960.1	6139.6	6328.4	59
60	4647.2	4772.9	4902.8	5037.2	5176.5	5321.1	5471.5	5628.2	5791.8	5963.0	6142.7	6331.7	60

MERIDIONAL PARTS.

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D. l.	72	73	74	75	76	77	78	79	80	81	82	83	D. l.
1	6334.9	6534.5	6745.7	6970.3	7210.1	7467.2	7744.5	8045.7	8375.3	8739.1	9145.5	9605.9	1
2	6338.1	6537.9	6749.4	6974.2	7214.2	7471.7	7749.6	8051.0	8381.0	8745.5	9152.7	9614.1	2
3	6341.4	6541.3	6753.0	6978.1	7218.3	7476.1	7754.2	8056.2	8386.8	8751.9	9159.9	9622.4	3
4	6344.6	6544.7	6756.6	6981.9	7222.5	7480.6	7759.0	8061.5	8392.6	8758.3	9167.2	9630.6	4
5	6347.8	6548.2	6760.3	6985.8	7226.6	7485.0	7763.9	8066.8	8398.3	8764.8	9174.4	9638.9	5
6	6351.1	6551.6	6763.9	6989.7	7230.8	7489.5	7768.7	8072.0	8404.1	8771.2	9181.6	9647.2	6
7	6354.3	6555.0	6767.6	6993.6	7234.9	7494.0	7773.5	8077.3	8409.9	8777.7	9188.9	9655.5	7
8	6357.6	6558.5	6771.2	6997.5	7239.1	7498.5	7778.4	8082.6	8416.8	8784.1	9196.2	9663.8	8
9	6360.9	6561.9	6774.9	7001.4	7243.3	7502.9	7783.2	8087.9	8421.9	8790.6	9203.5	9672.2	9
10	6364.1	6565.4	6778.5	7005.3	7247.5	7507.4	7788.1	8093.2	8427.4	8797.1	9210.8	9680.6	10
11	6367.4	6568.8	6782.2	7009.2	7251.6	7511.9	7793.0	8098.5	8433.3	8803.6	9218.1	9689.0	11
12	6370.6	6572.3	6785.8	7013.1	7255.8	7516.4	7797.8	8103.8	8439.1	8810.1	9225.4	9697.4	12
13	6373.9	6575.7	6789.5	7017.0	7260.0	7520.9	7802.7	8109.2	8445.0	8816.6	9232.7	9705.8	13
14	6377.2	6579.2	6793.2	7020.9	7264.2	7525.4	7807.6	8114.5	8450.9	8823.2	9240.2	9714.2	14
15	6380.5	6582.6	6796.9	7024.8	7268.4	7530.0	7812.5	8119.8	8456.8	8829.7	9247.6	9722.7	15
16	6383.7	6586.1	6800.5	7028.7	7272.6	7534.5	7817.4	8125.2	8462.6	8836.3	9255.0	9731.2	16
17	6387.0	6589.5	6804.2	7032.7	7276.8	7539.0	7822.3	8130.6	8468.6	8842.8	9262.4	9739.7	17
18	6390.3	6593.0	6807.9	7036.6	7281.0	7543.6	7827.2	8135.9	8474.5	8849.4	9269.9	9748.3	18
19	6393.6	6596.5	6811.6	7040.5	7285.2	7548.1	7832.2	8141.3	8480.4	8856.0	9277.3	9756.8	19
20	6396.9	6600.0	6815.3	7044.5	7289.4	7552.7	7837.1	8146.7	8486.3	8862.6	9284.8	9765.4	20
21	6400.2	6603.4	6819.0	7048.4	7293.7	7557.2	7842.0	8152.1	8492.3	8869.3	9292.3	9774.0	21
22	6403.5	6606.9	6822.7	7052.4	7297.9	7561.8	7847.0	8157.5	8498.2	8875.9	9299.8	9782.7	22
23	6406.8	6610.4	6826.4	7056.3	7302.1	7566.3	7851.9	8162.9	8504.2	8882.6	9307.3	9791.3	23
24	6410.1	6613.9	6830.1	7060.3	7306.4	7570.9	7856.9	8168.3	8510.2	8889.2	9314.8	9800.0	24
25	6413.4	6617.4	6833.8	7064.2	7310.6	7575.5	7861.9	8173.7	8516.2	8895.9	9322.4	9808.6	25
26	6416.7	6620.9	6837.6	7068.2	7314.9	7580.1	7866.8	8179.2	8522.2	8902.6	9330.0	9817.3	26
27	6420.0	6624.4	6841.3	7072.2	7319.1	7584.7	7871.8	8184.6	8528.2	8909.3	9337.6	9826.1	27
28	6423.3	6627.9	6845.0	7076.2	7323.4	7589.3	7876.8	8190.1	8534.2	8916.0	9345.2	9834.8	28
29	6426.6	6631.4	6848.7	7080.1	7327.7	7593.9	7881.8	8195.5	8540.2	8922.7	9352.8	9843.6	29
30	6429.9	6635.0	6852.5	7084.1	7332.0	7598.5	7886.8	8201.0	8546.2	8929.5	9360.4	9852.4	30
31	6433.2	6638.5	6856.2	7088.1	7336.2	7603.1	7891.8	8206.5	8552.3	8936.2	9368.1	9861.3	31
32	6436.6	6642.0	6860.0	7092.1	7340.4	7607.7	7896.8	8212.0	8558.4	8943.0	9375.8	9870.1	32
33	6439.9	6645.5	6863.7	7096.1	7344.8	7612.3	7901.9	8217.5	8564.4	8949.8	9383.5	9879.0	33
34	6443.2	6649.1	6867.5	7100.1	7349.1	7617.0	7906.9	8223.0	8570.5	8956.6	9391.2	9887.8	34
35	6446.6	6652.6	6871.2	7104.1	7353.4	7621.6	7911.9	8228.5	8576.6	8963.4	9398.9	9896.7	35
36	6449.9	6656.1	6875.0	7108.2	7357.7	7626.3	7917.0	8234.1	8582.7	8970.2	9406.6	9905.7	36
37	6453.3	6659.7	6878.7	7112.2	7362.0	7630.9	7922.1	8239.6	8588.9	8977.1	9414.4	9914.6	37
38	6456.6	6663.2	6882.5	7116.2	7366.4	7635.6	7927.1	8245.1	8595.0	8983.9	9422.1	9923.6	38
39	6460.0	6666.8	6886.3	7120.2	7370.7	7640.2	7932.2	8250.7	8601.1	8990.8	9429.9	9932.7	39
40	6463.3	6670.3	6890.1	7124.3	7375.0	7644.9	7937.3	8256.3	8607.3	8997.7	9437.8	9941.7	40
41	6466.7	6673.9	6893.8	7128.3	7379.4	7649.6	7942.4	8261.8	8613.5	9004.6	9445.6	9950.8	41
42	6470.0	6677.4	6897.6	7132.3	7383.7	7654.3	7947.5	8267.4	8619.6	9011.5	9453.4	9959.8	42
43	6473.4	6681.0	6901.4	7136.4	7388.0	7659.0	7952.6	8273.0	8625.8	9018.4	9461.3	9968.9	43
44	6476.8	6684.6	6905.2	7140.4	7392.4	7663.7	7957.7	8278.6	8632.0	9025.4	9469.1	9978.0	44
45	6480.1	6688.1	6909.0	7144.5	7396.8	7668.4	7962.8	8284.2	8638.2	9032.3	9477.0	9987.2	45
46	6483.5	6691.7	6912.8	7148.6	7401.1	7673.1	7968.0	8289.9	8644.5	9039.3	9484.9	9996.3	46
47	6486.9	6695.3	6916.6	7152.6	7405.5	7677.8	7973.1	8295.5	8650.7	9046.3	9492.9	10005.5	47
48	6490.3	6698.9	6920.4	7156.7	7409.9	7682.6	7978.2	8301.1	8656.9	9053.3	9500.8	10014.8	48
49	6493.6	6702.4	6924.2	7160.8	7414.2	7687.3	7983.4	8306.8	8663.2	9060.3	9508.8	10024.0	49
50	6497.0	6706.0	6928.1	7164.9	7418.6	7692.0	7988.5	8312.4	8669.5	9067.3	9516.8	10033.3	50
51	6500.4	6709.6	6931.9	7169.0	7423.0	7696.8	7993.7	8318.1	8675.7	9074.4	9524.8	10042.6	51
52	6503.8	6713.2	6935.7	7173.0	7427.4	7701.5	7998.9	8323.8	8682.0	9081.4	9532.9	10051.9	52
53	6507.2	6716.8	6939.5	7177.1	7431.8	7706.3	8004.0	8329.4	8688.3	9088.5	9540.9	10061.3	53
54	6510.6	6720.4	6943.4	7181.2	7436.2	7711.0	8009.2	8335.1	8694.6	9095.6	9548.9	10070.6	54
55	6514.0	6724.0	6947.2	7185.3	7440.6	7715.8	8014.4	8340.8	8701.0	9102.7	9557.0	10080.0	55
56	6517.4	6727.6	6951.1	7189.5	7445.0	7720.6	8019.6	8346.6	8707.3	9109.8	9565.1	10089.4	56
57	6520.8	6731.2	6954.9	7193.6	7449.5	7725.4	8024.8	8352.3	8713.6	9116.9	9573.2	10098.9	57
58	6524.2	6734.9	6958.8	7197.7	7453.9	7730.2	8030.0	8358.0	8720.0	9124.0	9581.4	10108.4	58
59	6527.6	6738.5	6962.6	7201.8	7458.3	7735.0	8035.2	8363.7	8726.4	9131.2	9589.5	10117.9	59
60	6531.0	6742.1	6966.5	7205.9	7462.8	7739.8	8040.5	8369.5	8732.7	9138.4	9597.7	10127.4	60
D. l.	72	73	74	75	76	77	78	79	80	81	82	83	D. l.

The Use of the TABLE of MERIDIONAL PARTS.

The lines at the top and bottom of the table, numbered from 0, 1, 2, 3, &c. are the degrees of latitude; and the numbers under (') in the right and left hand side columns, are the minutes of each degree. And the numbers under the degrees, and against any number of minutes are the meridional parts of those degrees and minutes. Thus the meridional parts of 10° are 603,1, and of $20^{\circ}.20'$ are 1246,4, and of $49^{\circ}.57'$ are 3470; and so of others.

To find the Meridional Difference of Latitude of two Places.

C A S E I.

If the latitude of both places be of the same name, N. or S. their diff. is the mer. diff. of latitude.

C A S E II.

If one place be in N. and the other in S. latitude, the sum of the meridional parts is their mer. diff. of latitude.

To construct MERCATOR'S CHARTS by a Table of Meridional Parts.

A Table of Meridional Parts to each 5 Degrees of Latitude. Also a Table of the Meridional Parts between each Degree of Latitude from 30° to 65° of Latitude, for the constructing of Mercator's Charts.

T A B L E I.

Lat.	M.pts.	Divided by 60 gives de- grees & pts.	Lat.	M.pts.	Divided by 60 gives de- grees.	Lat.	M.pts.	Divided by 60 gives de- grees.
Deg.	'	°	Deg.	'	°	Deg.	'	°
0 to 5	300	5,00	30 to 35	356,3	5,92	60 to 65	652	10,87
5 10	303	5,05	35 40	378,4	6,30	65 70	784	13,07
10 15	307	5,10	40 45	407,3	6,80	70 75	1004	16,73
15 20	315	5,25	45 50	444,5	7,4	75 80	1405	23,42
20 25	325	5,40	50 55	493,5	8,2	80 85	2390	39,83
25 30	338	5,64	55 60	559,4	9,3	85 90	infinite.	

II. A TABLE of MERIDIONAL PARTS for each Degree.

Lat.	M.pts.	Divid. by 60 is deg.	Lat.	M.pts.	Divid. by 60 is deg.	Lat.	M.pts.	Divid. by 60 is deg.	Lat.	M.pts.	Divid. by 60 is deg.
Deg.	'	°	Deg.	'	°	Deg.	'	°	Deg.	'	°
30 to 31	70,0	1,17	40 to 41	78,9	1,31	50 to 51	94,3	1,57	60 to 61	121,9	2,06
31 32	70,3	1,18	41 42	80,1	1,33	51 52	96,4	1,61	61 62	125,7	2,10
32 33	71,3	1,19	42 43	81,4	1,36	52 53	98,6	1,64	62 63	130,0	2,17
33 34	71,9	1,20	43 44	82,6	1,38	53 54	100,9	1,68	63 64	134,0	2,23
34 35	72,8	1,21	44 45	84,3	1,40	54 55	103,3	1,72	64 65	139,3	2,32
35 36	73,7	1,23	45 46	85,6	1,43	55 56	105,9	1,77	65 66	144,8	2,41
36 37	74,7	1,24	46 47	87,2	1,45	56 57	108,8	1,81	66 67	150,4	2,51
37 38	75,6	1,26	47 48	88,8	1,48	57 58	111,6	1,86	67 68	156,9	2,61
38 39	76,7	1,28	48 49	90,5	1,51	58 59	114,9	1,91	68 69	163,7	2,73
39 40	77,7	1,29	49 50	92,4	1,54	59 60	118,2	1,97	69 70	171,4	2,86

To

To lay down Numbers by the Sector, as in Table I.

1. Open your compasses to the proposed distance for 5° of longitude, and open the sector till that extent reach from 5 to 5° on the line of lines; and let the sector remain at that distance.
2. Draw the first meridian, and set off at right angles from it, each 5° of longitude, and number them accordingly.
3. Then take off the distances of each 5° of latitude, (from Table I.) and lay them on your meridian line in the chart, and draw lines through each 5° of latitude for the parallels of latitude.
4. Draw those of longitude to each 5° parallel to each other.
5. Subdivide the latitude and longitude lines that are to be numbered into each degree.
6. Set off the latitude and longitude of each place of note, also the sands, capes, rocks and headlands.
7. Draw the coasts, the compass, the depths of water in fathoms, to be numbered where it is known; and the time of high water on the full and change days of the moon, to be noted with large Roman figures.

To make a MERCATOR'S CHART, and to set off the Place of a Ship every Day at Noon in it.

THIS chart may be drawn by two methods. 1. by Gunter's scale. (See the chart. (Plate 1.)

Draw the right line DAC for the Equator, and AB perpendicular to it for a meridian, upwards for North latitude; then with your compasses take 10, 20, 30, &c. from the line EP, and set from A to 10, 20, &c. each way towards D and C, through which points draw lines parallel to DE or CF, for meridians, as 10, 20, &c. Then with your compasses take 10, 20, 30, 40, 50, 60, &c. from the line of meridional parts, and set these extents from C towards F, to 10, 20, 30, &c. through all which points draw lines parallel to the equator DAC, for parallels of latitude, as 10, 20, 30, 40, 50, 60. Likewise from the line mer. pts. set off the intermediate degrees and parts on the line CF. Then graduate (that is, divide) the equator DAC, and the meridians DE and CF, and number them accordingly; and in one or more places draw the mariner's compass, with the rumbs. If you draw meridians and parallels in like manner, below the equator DAC, you will have a chart for south latitude.

2. To make a MERCATOR'S CHART by Meridional Parts, to be set off from a Scale of Equal Parts:

DRAW the meridians and longitude lines, by setting off in the meridian of the chart the meridional parts contained in each degree, from a scale of equal parts, proper for the chart; also set off 60' for each degree of longitude on the East and West lines, and finish the chart in the same manner as above directed.

To measure distances in the chart.

1. The difference of longitude is to be measured on the E. or W. graduated lines.
2. The departure and the distance are always to be measured in the meridian, by setting one foot of the compasses above one of the given latitudes, and the other foot as much below the other latitude: If both places lie in one parallel, do in like manner. See the following rules.

To find the Bearing and Distance of Places in a Mercator's Chart,

C A S E I.

When the given places differ only in latitude, take the distance from one place to the other in the compasses, and apply it to the graduated meridian, in the parallels of the given latitudes; and the degrees contained between the points of the compasses will be the distance.

Y

C A S E

C A S E II.

When the places differ only in longitude, take the distance between the places in the compasses, and apply it to the line of longitude; the degrees contained will be the difference of longitude. The same distance applied to the latitude line, with one foot as much below as the other is above the given latitude, will shew the dist. between the places in the given parallel.

C A S E III.

Draw a pencil line from one of the given places to the other, and then take their diff. of latitude in degrees and minutes in the compasses, from the line of longitude; and apply that extent, with one foot in the pencil line, and the other N. or S. of it; move the compasses so that one foot may keep in the pencil line, till the other touch some E. or W. line, which crosses the pencil line; turn the compasses on the point in the pencil line, to find if the other foot will only just touch the parallel of latitude line; the distance of that point in the pencil line, to the point of section of the parallel line and pencil line, being taken in the compasses, and applied to the line of longitude, will give the distance required.

C A S E IV.

To find the bearing of places. Lay a scale or ruler on the two places, whose bearing from each other is required; then apply one foot of the compasses to the center of some compass of the chart, and make the other foot touch the ruler perpendicularly; move the compasses in a parallel position, with one foot against the edge of the ruler, and observe that rumb-line of the compass, in which the foot from the center moves in, or nearest to; which rumb will shew the bearing required.

Or, apply a parallel ruler to the given places, and move its fiducial edge, parallel-wise, till it cut the center of a compass, and that edge will shew the bearing by that compass.

In like manner the bearings and distances of ports, sands, capes, rocks, &c. may be found, from any place of a ship denoted in the chart.

To make a REDUCED CHART of the British Channel.

BY a Reduced Chart is to be understood a chart nearly similar to Mercator's. The principles are as follow:

1. The meridians are to be drawn parallel to each other, and the degrees of latitude equal.
2. The longitude lines are to be drawn parallel to each other, across the chart, to each degree, or to each 5 or 10 degrees, according to the scale of the chart.

Suppose you are to draw a chart of the British Channel, which is to be contained between

The lat. of 48°N. and lon. $2^{\circ}.30'\text{E.}$

And the lat. of 52°N. and lon. $7^{\circ}.30'\text{W.}$

Extent of the chart in lat. 4° in lon. $10^{\circ}.00$

These degrees of latitude and longitude are to be laid down on a sheet of paper, suppose 20 inches long by 14; you are to set off for the margin, and for the lines (or scales) of the degrees and minutes of latitude and longitude about $\frac{3}{4}$ of an inch round the border, and then you will have 18,5 for longitude, and 12,5 for latitude.

Now if 10° lon. require 18,5 inches, what will 1° require? Answer, 1,85 inches for 1° of longitude.

To find what 1° of latitude will require.

The middle latitude of the chart is 50° , and the minutes in 1° of longitude in that latitude is 38',567: If 38',567 require 1,85 inches, 60' will require 2,88 inches for 1° of latitude.

But

But if the scale of the chart be double to the above, then 1° of longitude will be equal to 3,7, and 1° of latitude equal to 5,76 inches.

Draw a line across the bottom of the sheet, and another perpendicular to it, on the East side for a meridian; draw another meridian on the West side, and a longitude line at the top; divide the space between the East and West meridians into 10 equal parts, and draw black lead pencil lines of latitude; then bisect each distance of these degrees of longitude, and draw ink line meridians, and reckon from the East side of the chart $2^\circ.30'$ Westerly, and number that meridian (o) for the first meridian, or that of London. Number the other meridians 1, 2, 3, &c. towards the West, and number those towards the East; number also such other intermediate meridians as you think necessary for constructing the chart.

The parallels of latitude must be drawn to each degree of latitude, and numbered; and the intermediate parallel may be drawn with a black lead pencil to each $10'$ of latitude, which may be rubbed out after the plan is finished.

The principal places are to be marked in the plan, as they are in latitude and longitude in the best tables you have or can get; which being done, the coasts, inlets, bays, straits, &c. may be drawn by their representation in some other chart or charts; also draw compasses in proper places, where ships mostly pass, and draw a scale of distance; write the title and principles of the chart, with such remarks as are necessary, and the time of high water on the full and change days of the moon, draw darts with points tending the way the tide flows; number the depths of the water in fathoms, and your chart will be properly finished.

Remarks on the Construction of Charts.

1. The plane chart can only be of general use for places, or parts of the earth, within the torrid zone, where the degrees of latitude and longitude are nearly equal.

2. Mercator's chart may be of general use; but notwithstanding this property, the places in it, with respect to each other, are greatly distorted, having their distances enlarged in the proportion of the cosine of the latitude to the radius; where the distance in this chart from any one place to another, in the parallel of 60° latitude, will be double of the true distance; and in the latitude of 50° it will be more than $\frac{1}{3}$ of the true distance too great; that is, so much more than the distance on the globe or surface of the earth. (For an ocular demonstration, see the Artificial Terrestrial Globe, where the surface of the earth, the meridians, parallels of latitude, &c. are delineated, nearly similar to those of the earth.)

3. The reduced chart is greatly preferable to Mercator's *, as well as to the plane chart; for it is delineated in such a manner as to have the bearings and distances of places nearly true; which will appear by what follows:

Suppose the chart is to be made of a part of the earth from 24° to 30° latitude, and from 10° to 30° longitude. (*)

In the lat. 24° are 54,81 in 1° of lon.

And in lat. 30° are 51,96 in 1° do.

Sum 106,77

$\frac{1}{2}$ Sum is 53,385 the miles that each degree of lon. (in the chart) is to contain;

Extreme diff. 1,425

If 53,4' gives 1,4' what will 60' give?

60

534)840(1,57 the error in 60', when due East or West, at the extreme lat. of the chart, but in or near the middle there is no sensible error.

(*) The chart is to contain 20° of longitude, or $20 \times 53,385' = 1067,7'$, hence set off these equal parts from a proper scale (of equal parts) either the whole distance at once, which may be done by the beam compass (of a sufficient size for the plan), this is the best instrument

* When it is made for channels, or seas, where the extreme difference does not exceed 2 or 3 miles (error) in a degree, or $1'$ in 20, it is of little consequence.

for such purpose; but if you have only the common compasses to set off distances with, and that you cannot take the whole at once, you may draw pencil lines at the top and bottom of the paper designed for the chart, and set off from one side of it a convenient distance, which suppose to be 500, the same repeat, and then 67,7; these being set off both at the top and bottom, draw the other extreme meridian; divide the longitude line into four equal parts, draw the meridians, and number them 10° , 15° , 20° , 25° , 30° , &c. these being done, you may subdivide each 5° into single degrees, $\frac{1}{2}$ and $\frac{1}{4}$ degrees; then set off 60' for each degree of latitude; and the distances in the chart will measure nearly true: For the distances required to be known from the place of a ship (assumed in the chart) to any isle, rock, shoal, cape or coast, are rarely desired to be known at more than 10, 15, or 20 miles distance; but suppose it required at 60 miles, the error at that distance cannot exceed (if E. and W. and in lat. 30°) $1\frac{1}{2}$ mile.

If a chart of this kind was to be made of a part from the latitude of 50° to 60° , then
 1° lon. in 50° is $30', 57''$
 And 1° lon. in 60 is $30', 28''$ } $\frac{1}{2}$ diff. = 4, 28 the error in $34'$ E. or W.

Mean $\overline{34.28}$ whence the greatest error is 1' in $8\frac{1}{2}$.

Suppose the lat. 60° and 66 , then $\left\{ \begin{array}{l} 60^\circ \text{ gives } 30' \text{ to } 1^\circ \\ 66 \text{ gives } 24,4 \end{array} \right\}^{\frac{1}{2}} \text{ diff.} = 2',8, \text{ hence } 1' \text{ error in } 9',$
where it is the greatest.
Mean 27,2

Suppose the lat. 66° and 70° then 66 gives 24,4 } $\frac{1}{2}$ diff. is 2' the error in 22', or 1' in 11',
 And 70 20,4 } and the like of any other.

 Mean 22,0

Note. If 60' gives 1'·5 error, then 40' gives 1' error, and 1' will give 46 fathoms; which small defects are of little consequence, because in these circumstances, the pilots always keep the shoal-water lead going.

Remark. That the great use of sea-charts to mariners is, when they are near some coast, sand, rock, island, or the like; and when the commander of the ship, pilot, mate, or master, takes the charge of the ship under his care and direction, that he considers the place of the ship, the coasts, tides, &c. He then assigns the place of the ship in the chart, and finds his distance and bearing from all places of danger; he therefore finds the course he must make, and the distance, and gives orders for the ship to be steered accordingly. As they sail along a coast, he observes in his chart how near the high-water mark he may fail to keep the ship in the fair way, or in the proper channel, so as keep her clear of rocks and shoals.

To prick off the Place of a Ship in the Chart.

Lay a long straight ruler on the parallel of the latitude of the ship, and take in the compasses the meridional distances between some N. and S. line, and that which the ship is in, set that distance from the said N. and S. line, where the ruler cuts it, along the edge of the ruler, the same way as it was taken off, and you will have the place of the ship; make a small prick, and with your black lead pencil, or with red ink, make an (o), or small circle round it, and set the day of the month by it; in like manner do from day to day. You may draw a pencil line to shew the course and distance you have made good. Do in like manner with the latitude and longitude in the other charts.

Having learned the construction and use of sea charts, the next to learn will be, how to find the variation of the needle or compass, which may be obtained by comparing the true and magnetical azimuths. The magnetical amplitudes and azimuths are observed by the compass. The true amplitudes and azimuths are obtained by calculation.

A S T R O N O M Y.

Def. 1. **A**STRONOMY is a mixed mathematical science, by which we learn the knowledge of the celestial bodies (sun, moon and stars) their magnitudes, motions, distances, periods, eclipses, and their regular disposition; also their longitudes, latitudes, right ascensions and declinations, which are deduced from observations.

2. Observations are made, with proper instruments, of the altitudes, azimuths, diameters and angular distances of the sun, moon and stars; and those are necessary observations to be made for the use of navigation.

The first and principal observation is that, by which is determined the latitude of the ship; the second is the azimuth, in order to find the variation of the compass. (Of which see p. 34, 35, and the following pages.)

3. The equinoctial, is that great circle in the heavens, which the sun describes, when he makes equal day and night.

4. The plane of the equinoctial divides the globe of the earth, and also the heavens, into two equal parts, which are called the northern and southern hemispheres.

5. Declination of the sun (or other celestial body) is its distance from the equinoctial, and it is measured in an arch of the meridian, contained between the center of the sun, and the equinoctial; and if it be on the North of the equinoctial, it has North declination; but if it be on the South, it has South declination. The like of the moon and stars.

6. Horizon at sea is the utmost limits of our view, where the water and sky appear to meet. Rational horizon, is that plane supposed to pass through the earth's centre.

7. Altitude of the sun, &c. is its angular height above the horizon (Def. 15, p. 34.) Altitudes are observed with Hadley's reflecting instruments. (Of which see my Treatise on the Longitude, printed in 1773, price 2s. 6d.)

8. Meridian of a place, is the semi-circle conceived to pass from pole to pole, through the zenith of that place.

9. Meridian altitude, is the greatest altitude the sun (moon, or star) can have on any one day at the same place.

10. Zenith distance is the complement of altitude to 90° , or what will make the altitude 90° ; that is, the degrees and minutes of altitude taken from 90° , leaves the remainder, which is the zenith distance, or Z. D.

11. Zenith, is that point in the heavens right over our heads, and it is every where 90° above the true horizon in every direction: Nadir, is the point diametrically opposite to the zenith; therefore 90° below the horizon.

12. Azimuth circles, are those vertical circles conceived to pass from the zenith, and to intersect the horizon at right angles.

13. Azimuth of the sun, moon, or star, is its distance from the meridian; which is measured by an arch of the horizon contained between the meridian and the azimuth circle that passes through the sun, moon, or star: These horizontal arches are measured by the azimuth compass.

14. Amplitude, is the complement of the rising or setting azimuth, and it is always reckoned from the East in the morning, and from the West in the afternoon.

Note. The true amplitude is always of the same name with the declination. (See Def. 22. p. 42. of my Treatise on Longitude.)

Of Amplitude and Azimuth Observations of the Sun and Moon.

15. Magnetical amplitude, is the degrees and minutes the center of the sun, &c. is observed to rise or set from the direction of the East or West points of the compass.

Z

16. Mag-

Note. In this Treatise, we have denoted the middle of an apparent Surface (as the sun's) by center; and the middle considered as a solid, by centre.

16. *Magnetical azimuth*, is the degrees and minutes observed between the North or South points of the compass card, and the vertical circle the sun or moon is in, by the compass.

17. *Variation of the compass*, is an arch of the horizon contained between the true and the magnetic North; which quantity is equal to the difference between the true and magnetical azimuth.

18. *Daily variation of the sun's declination*, is its increase or decrease of distance (or declination) from the equinoctial (Def. 5.) made between the noon of one day and the noon of the succeeding day.

Art. 1. To find the variation of the needle by amplitudes, you must know the latitude you are in, the declination of the sun, and the magnetic amplitude; then find the true amplitude.

To find the true Amplitude of the Sun at its rising and setting. General Canon.

As the cosine of the latitude : R :: sine of the sun's declination : the sine of the true amplitude, which is of the same name as the declination; that is, when the declination is North, the rising amplitude will be North from the East; but the setting amplitude will be North from the West. When the declination is South, the rising and setting amplitudes will be South from the East or West points of the horizon.

2. To find the true amplitude of the Sun.

The sun's declination at the time of its rising or setting, should be found; but if the declination at noon be taken (and used), it may give the amplitude sufficiently near for to be compared with observed amplitudes, in general.

But when the observation is made by a good artist, and with a good compass, so that the variation be required to the greatest accuracy, then the declination should be found to the time of the observation reduced to the time then at Greenwich. (Of which see my Sea-Officer's Companion, 2d Edition.)

3. If the true and the magnetic amplitudes be both North, or both South, their difference will be the variation; but if one be North and the other South, the sum will be the variation.

To find which Way the Variation is, by Amplitudes.

4. Find the place of the true amplitude on the card, and then note, if the magnetic amplitude was observed towards the right hand of it, the variation is West; otherwise it is East.

Note. The cards of amplitude and azimuth compasses are numbered from the N. and S. points, to the E. and W. points, 10, 20, &c. to 90° each way. It sometimes happens that azimuths are observed on both sides, the E. or W. point of the compass, the same morning or evening, which circumstance should be regarded; and that you continue to reckon the succeeding azimuths, from the same meridian, and particularly when you propose to take the mean of them, in order to compute only one azimuth to be compared with the mean of them observed. (See examples in p. 99.)

5. A General Rule to find which way the Compass varies, by azimuths.

Of Azimuths observed in the Mornings, or Evenings.

Note. 1. When the latitude is N. and the azimuths are observed from the S. point of the compass, subtract each observed azimuth from 180°, and the remainder will be the magnetic azimuth, observed from the meridian of the same name as the latitude.

2. If you are in S. lat. and the az. observed be from the S. then subtract both the true and the observed azimuths from 180°, the remainders will be the azimuths from the North; but if the azimuth be observed from the N. subtract the true az. from 180°, the remainder will be the true az. from the North.

Remark. That the true and observed azimuths must always be reduced (as above directed) to their bearing in respect of the same meridian, which in this Rule and Articles are adapted for the North.

3. Then, if the observed az. be greater than the true az. in the mornings, or less than the true in the evenings, the diff. is the var. W. but if the observed az. be less than the true in the mornings, or greater than the true az. in the evenings, the diff. is the var. E. (See p. 99.)

A TABLE

T A B L E I.

A TABLE of the SUN'S DECLINATION for Leap Years, which are 1776, 1780, 1784, 1788, 1792, and 1796.

Mo.	Jan.	Feb.	March	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day.	South.	South	South.	North.	North.	North.	North.	North.	North.	South	South	South
	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "
1	23.01	17.07	7.13	4.54	15.21	22.11	23.05	17.50	7.59	3.32	14.44	21.59
2	22.56	16.49	6.50	5.17	15.39	22.19	23.00	17.35	7.37	3.55	15.03	22.07
3	22.50	16.32	6.27	5.40	15.56	22.26	22.55	17.19	7.15	4.18	15.22	22.16
4	22.44	16.14	6.04	6.02	16.13	22.33	22.50	17.03	6.53	4.41	15.41	22.24
5	22.38	15.56	5.41	6.25	16.30	22.39	22.44	16.47	6.31	5.04	15.59	22.31
6	22.31	15.38	5.18	6.48	16.47	22.45	22.38	16.30	6.09	5.28	16.17	22.38
7	22.23	15.19	4.54	7.10	17.04	22.51	22.32	16.13	5.46	5.51	16.35	22.44 ¹
8	22.15	15.00	4.31	7.32	17.20	22.56	22.25	15.56	5.23	6.13	16.52	22.51
9	22.07	14.41	4.08	7.55	17.36	23.01	22.17	15.39	5.00	6.36	17.09	22.56
10	21.58	14.22	3.44	8.17	17.51	23.06	22.10	15.21	4.38	6.59	17.26	23.01 ¹
11	21.49	14.02	3.21	8.39	18.06	23.10	22.02	15.03	4.15	7.22	17.42	23.06
12	21.40	13.42	2.57	9.01	18.21	23.14	21.53	14.45	3.52	7.44	17.58	23.10
13	21.30	13.22	2.33	9.22	18.36	23.17	21.44	14.26	3.29	8.07	18.14	23.14
14	21.19	13.02	2.10	9.44	18.51	23.20	21.35	14.07	3.06	8.29	18.30	23.18
15	21.08	12.41	1.46	10.05	19.05	23.22	21.26	13.48	2.42	8.52	18.45	23.21
16	20.57	12.21	1.22	10.26	19.17	23.24	21.16	13.30	2.19	9.14	19.00	23.23
17	20.40	12.00	0.59	10.47	19.32	23.26	21.05	13.10	1.55	9.36	19.14	23.25
18	20.33	11.39	0.35	11.08	19.45	23.27	20.55	12.51	1.32	9.57	19.28	23.26
19	20.21	11.17	0.11 S	11.29	19.58	23.28	20.44	12.31	1.09	10.19	19.42	23.27
20	20.08	10.56	0.13 N	11.49	20.10	23.28	20.32	12.11	0.45	10.41	19.56	23.28
21	19.55	10.34	0.36	12.10	20.22	23.28	20.20	11.51	0.22 N	11.02	20.09	23.28 ¹
22	19.41	10.13	1.00	12.30	20.34	23.27	20.08	11.31	0.02 S	11.23	20.22	23.27 ¹
23	19.27 ¹	9.51	1.24	12.50	20.45	23.26	19.56	11.10	0.25	11.44	20.34	23.27
24	19.13	9.29	1.47	13.10	20.56	23.25	19.43	10.50	0.48	12.05	20.46	23.26
25	18.58	8.07	2.11	13.29	21.07	23.24	19.30	10.29	1.12	12.26	20.57 ¹	23.24
26	18.43	8.44	2.34	13.48	21.17	23.22	19.17	10.08	1.35	12.46	21.09	23.21
27	18.28	8.21	2.58	14.07	21.27	23.19	19.03	9.47	1.58	13.06	21.19 ¹	23.18
28	18.13	7.59	3.21	14.26	21.37	23.16	18.49	9.26	2.22	13.26	21.30	23.15
29	17.57	7.36	3.45	14.44	21.46	23.13	18.35	9.04	2.45	13.46	21.40	23.11
30	17.40		4.08	15.03	21.55	23.09	18.20	8.43	3.08	14.06	21.49	23.07
31	17.24		4.31		22.03		18.05	8.21		14.25		23.02

The Use of the TABLE of the SUN'S DECLINATION.

- Article 1. It is used for finding the latitude of a place.
 2. It is used for finding the time of the day, in a known latitude, where the longitude is nearly known, suppose within 15 or 20°.
 3. In finding the altitude or azimuth of the sun in a known latitude, at any time of the day.

A TABLE

A TABLE of the SUN'S DECLINATION for the Years 1777, 1781, 1785, 1689, 1793, and 1797, being the First Years after Leap Year.

Mo.	Jan.	Feb.	March.	April.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day.	South	South	South	North.	North.	North.	North.	North.	North.	South	South	South
1	22.58	16.54	7.19	4.48	15.16	22.09	23.06	17.55	8.05	3.26	14.40	21.56
2	22.52	16.37	6.56	5.11	15.34	22.17	23.02	17.39	7.43	3.49	14.59	22.05
3	22.46	16.19	6.33	5.34	15.51	22.24	22.57	17.23	7.21	4.12	15.17	22.14
4	22.40	16.01	6.10	5.57	16.09	22.31	22.52	17.07	6.59	4.35	15.36	22.22
5	22.33	15.42	5.47	6.20	16.26	22.38	22.46	16.51	6.37	4.58	15.54	22.29
6	22.26	15.24	5.24	6.42	16.43	22.44	22.40	16.35	6.14	5.22	16.12	22.36
7	22.18	15.05	5.00	7.05	16.59	22.50	22.34	16.18	5.52	5.45	16.30	22.43
8	22.10	14.46	4.37	7.27	17.15	23.55	22.27	16.00	5.29	6.08	16.47	22.49
9	22.01	14.27	4.14	7.49	17.31	23.00	22.19	15.43	5.06	6.30	17.04	22.55
10	21.52	14.07	3.50	8.12	17.47	23.05	22.12	15.26	4.43	6.53	17.21	23.00
11	21.42	13.47	3.27	8.33	18.02	23.09	22.04	15.08	4.21	7.16	17.38	23.05
12	21.32	13.27	3.03	8.55	18.17	23.13	21.56	14.50	3.58	7.38	17.54	23.09
13	21.22	13.07	2.39	9.17	18.32	23.16	21.47	14.31	3.35	8.01	18.10	23.13
14	21.11	12.47	2.16	9.39	18.47	23.19	21.38	14.13	3.12	8.23	18.25	23.17
15	21.00	12.26	1.52	10.00	19.01	23.22	21.28	13.54	2.48	8.46	18.40	23.20
16	20.49	12.05	1.28	10.21	19.15	23.24	21.18	13.35	2.25	9.08	18.56	23.23
17	20.37	11.44	1.05	10.42	19.28	23.25	21.08	13.16	2.02	9.30	19.11	23.25
18	20.24	11.23	0.41	11.03	19.41	23.27	20.58	12.56	1.39	9.52	19.25	23.26
19	20.11	11.01	0.17 S	11.24	19.54	23.28	20.47	12.37	1.15	10.13	19.39	23.27
20	19.58	10.40	0.06 N	11.44	20.07	23.28	20.36	12.17	0.52	10.35	19.52	23.28
21	19.45	10.18	0.30	12.04	20.19	23.28	20.24	11.57	0.29	10.56	20.05	23.28
22	19.31	9.56	0.54	12.24	20.31	23.28	20.12	11.37	0.05 N	11.17	20.18	23.28
23	19.17	9.34	1.17	12.44	20.42	23.27	20.00	11.16	0.19 S	11.39	20.31	23.27
24	19.02	9.12	1.41	13.04	20.53	23.26	19.47	10.56	0.42	12.00	20.43	23.26
25	18.47	8.50	2.04	13.24	21.04	23.24	19.34	10.35	1.05	12.21	20.55	23.24
26	18.32	8.27	2.28	13.43	21.14	23.22	19.21	10.14	1.29	12.41	21.06	23.22
27	18.17	8.04	2.52	14.02	21.24	23.20	19.07	9.53	1.52	13.01	21.17	23.19
28	18.01	7.42	3.15	14.21	21.34	23.17	18.53	9.32	2.16	13.21	21.27	23.16
29	17.44		3.38	14.39	21.43	23.14	18.39	9.11	2.39	13.41	21.37	23.13
30	17.28		4.01	14.58	21.52	23.10	18.25	8.49	3.02	14.01	21.47	23.09
31	17.11		4.24		22.01		18.10	8.27		14.20		23.04

To find the Declination of the Sun at any Time and Place.

Art. 4. Take out of the table the declination for the given year, month and day; and if the longitude you are in exceed 10° , the declination must be corrected thus:

5. Convert the degrees of longitude, from the meridian of Greenwich, into time, at the rate of 4' of time for each degree; or 1h. for 15° ; and 1' for $15'$ of longitude.

6. If you be in W. longitude, add the converted time to the time where you are, and the sum will be the time at Greenwich; but if you be in E. longitude, subtract it, and the remainder will be the time at Greenwich (or at the meridian of Greenwich) which time must always be used, to enter Table II. with in p. 95; in the first col. and against that time, or the

A TABLE of the SUN'S DECLINATION for the Years 1778, 1782, 1786, 1790, 1794, and 1798, being the Second Years after Leap Year.

Mo.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day.	South	South	South	North	North	North	North	North	North	South	South	South
1	22.59	16.59	7.26	4.41	15.11	22.07	23.07	17.58	8.11	3.19	14.34	21.54
2	22.54	16.41	7.03	5.04	15.29	22.15	23.03	17.43	7.49	3.42	14.53	22.03
3	22.48	16.24	6.40	5.27	15.47	22.22	22.58	17.27	7.27	4.06	15.12	22.11
4	22.41	16.06	6.17	5.50	16.04	22.29	22.53	17.11	7.05	4.29	15.31	22.19
5	22.35	15.48	5.54	6.13	16.21	22.36	22.47	16.55	6.43	4.52	15.49	22.27
6	22.28	15.29	5.30	6.35	16.38	22.42	22.41	16.39	6.20	5.15	16.07	22.34
7	22.20	15.10	5.07	6.58	16.55	22.48	22.35	16.22	5.58	5.38	16.25	22.41
8	22.12	14.51	4.44	7.20	17.11	22.54	22.28	16.05	5.35	6.01	16.43	22.47
9	22.03	14.32	4.20	7.43	17.27	22.59	22.21	15.48	5.12	6.24	17.00	22.53
10	21.54	14.13	3.57	8.05	17.43	23.03	22.13	15.30	4.50	6.47	17.17	22.59
11	21.45	13.53	3.33	8.27	17.58	23.08	22.06	15.12	4.27	7.10	17.33	23.04
12	21.35	13.33	3.10	8.49	18.14	23.11	21.57	14.54	4.04	7.32	17.50	23.08
13	21.25	13.13	2.46	9.11	18.28	23.15	21.49	14.36	3.41	7.55	18.06	23.12
14	21.14	12.52	2.22	9.32	18.43	23.18	21.40	14.18	3.18	8.17	18.21	23.16
15	21.03	12.32	1.59	9.54	18.57	23.21	21.30	13.59	2.55	8.40	18.37	23.19
16	20.52	12.11	1.35	10.15	19.11	23.23	21.21	13.40	2.31	9.02	18.52	23.22
17	20.40	11.50	1.11	10.36	19.25	23.25	21.11	13.21	2.08	9.24	19.06	23.24
18	20.28	11.29	0.47	10.57	19.38	23.26	21.00	13.01	1.45	9.46	19.21	23.26
19	20.15	11.07	0.24N	11.18	19.51	23.27	20.49	12.42	1.22	10.07	19.35	23.27
20	20.02	10.46	0.00	11.39	20.04	23.28	20.38	12.22	0.58	10.29	19.48	23.28
21	19.49	10.24	0.24S	11.59	20.16	23.28	20.27	12.02	0.35	10.50	20.02	23.28
22	19.35	10.02	0.48	12.19	20.28	23.28	20.15	11.42	0.11N	11.12	20.15	23.28
23	19.21	9.40	1.11	12.39	20.39	23.27	20.03	11.22	0.12S	11.33	20.27	23.27
24	19.06	9.18	1.35	12.59	20.50	23.26	19.50	11.01	0.35	11.54	20.39	23.26
25	18.52	8.56	1.58	13.18	21.01	23.24	19.37	10.40	0.59	12.15	20.51	23.24
26	18.36	8.34	2.21	13.38	21.12	23.22	19.24	10.20	1.22	12.35	21.03	23.22
27	18.21	8.11	2.45	13.57	21.22	23.20	19.11	9.59	1.46	12.55	21.14	23.20
28	18.05	7.48	3.08	14.16	21.33	23.18	18.57	9.37	2.09	13.16	21.24	23.17
29	17.49		3.32	14.34	21.41	23.14	18.43	9.16	2.32	13.36	21.34	23.13
30	17.33		3.55	14.53	21.50	23.11	18.28	8.55	2.56	13.55	21.44	23.09
31	17.16		4.18		21.59		18.13	8.33		14.15		23.05

the nearest to it in hours, and under the daily alteration of the Sun's declination, you will have the minutes to be applied to the declination that day at noon, under the meridian of Greenwich.

7. Note. When the declination is increasing, add the minutes of increase for the time afternoon at Greenwich; but for the hours that are wanted to noon, or before noon, subtract the increase of declination, and you will have the true declination required.

Also if the declination of the sun be decreasing, subtract the minutes for the time afternoon; but for the hours before noon, add the decrease of declination, and you will have the true declination.

A TABLE of the Sun's Declination for the Years 1779, 1783, 1787, 1791, 1795, and 1779, being the Third Years after Leap Year.

Mo.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Day.	South	South	South	North	North	North	North	North	North	South	South	South
1	23.00	17.03	7.31	4.36	15.07	22.05	23.08	18.02	8.16	3.14	14.30	21.52
2	22.55	16.46	7.08	4.59	15.25	22.13	23.04	17.47	7.54	3.37	14.49	22.01
3	22.49	16.28	6.45	5.22	15.42	22.20	22.59	17.32	7.32	4.00	15.08	22.09
4	22.43	16.10	6.22	5.45	16.00	22.28	22.54	17.15	7.10	4.23	15.26	22.18
5	22.36	15.52	5.59	6.07	16.17	22.34	22.49	16.59	6.48	4.46	15.45	22.25
6	22.29	15.33	5.36	6.30	16.34	22.41	22.43	16.43	6.26	5.10	16.03	22.33
7	22.22	15.15	5.13	6.53	16.51	22.47	22.37	16.26	6.03	5.33	16.21	22.40
8	22.14	14.56	4.49	7.15	17.07	22.52	22.30	16.09	5.41	5.56	16.38	22.46
9	22.05	14.37	4.26	7.37	17.23	22.57	22.23	15.52	5.18	6.19	16.56	22.52
10	21.56	14.17	4.02	8.00	17.39	23.02	22.16	15.34 ¹ / ₂	4.55	6.41	17.13	22.57
11	21.47	13.58	3.39	8.22	17.55	23.07	22.08	15.17	4.33	7.04	17.29	23.02 ¹ / ₂
12	21.37	13.38	3.15	8.44	18.10	23.11	22.00	14.59	4.10	7.27	17.46	23.07
13	21.27	13.18	2.52	9.05	18.25	23.14	21.51	14.41	3.47	7.49	18.02	23.11
14	21.17	12.57	2.28	9.27	18.39	23.17	21.42	14.22	3.24	8.12	18.17	23.15
15	21.06	12.37	2.04	9.49	18.54	23.20	21.33	14.04	3.01 ¹ / ₂	8.34	18.33	23.18
16	20.54	16.16	1.41	10.10	19.08	23.22	21.23	13.45	3.37	8.56	18.48	23.21
17	20.43	11.55	1.17	10.31	19.21	23.24	21.13	13.26	2.14	9.18	19.03	23.23
18	20.31	11.34	0.53	10.52	19.35	23.26	21.03	13.06	1.51	9.40	19.17	23.25
19	20.18	11.13	0.30	11.13	19.48	23.27	20.52	12.47	1.27 ¹ / ₂	10.02	19.31	23.27
20	20.05	10.51	0.06S	11.33	20.00	23.28	20.41	12.27	1.04	10.24	19.45	23.28
21	19.52	10.29	0.18N	11.54	20.13	23.28	20.30	12.07	0.41	10.45	19.59	23.28
22	19.38	10.08	0.41	12.14	20.25	23.28	20.18	11.47	0.17N	11.07	20.12	23.28
23	19.24	9.46	1.05	12.34	20.36	23.27	20.06	11.27	0.06S	11.28	20.24	23.27
24	19.10	9.24	1.28	12.54	20.48	23.26	19.53	11.06	0.30	11.49	20.37	23.26
25	18.55	9.01	1.52	13.14	20.59	23.25	19.40	10.45	0.53	12.10	20.49	23.25
26	18.40	8.39	2.15	13.33	21.09	23.23	19.27	10.25	1.17	12.30	21.00	23.23
27	18.25	8.16	2.39	13.52	21.19	23.21	19.14	10.04	1.40	12.51	21.11	23.21
28	18.09	7.54	3.02	14.11	21.29	23.18	19.00	9.42	2.03	13.11	21.22	23.18
29	17.53		3.26	14.30	21.39	23.15	18.46	9.21	2.27	13.31	21.32	23.14
30	17.37		3.49	14.48	21.48	23.12	18.32	9.00	2.50	13.51	21.42	23.11
31	17.20		4.12		21.56		18.17	8.38		14.10		23.06 ¹ / ₂

8. The daily alteration of declination, is the difference between the declination that day at noon, and the declination at noon the following day. And when you take that difference you will see whether the declination be increasing or decreasing.

9. The declination increases from the 21st of March to the 21st of June, and from the 22d of September to the 21st of December.

But it decreases from the 20th of June to the 22d of September, and from the 21st of December till the 20th of March.

TABLE

T A B L E II.

A TABLE of the daily Variation of the SUN'S DECLINATION for the Hours of each Day.

H.	22	20	18	16	14	12	10	8	6	4	2
1	1	1	1	1	1	$\frac{1}{2}$	0	0	0	0	0
2	2	2	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$	0	0	0
3	3	$2\frac{1}{2}$	2	2	2	$1\frac{1}{2}$	1	1	1	0	0
4	$3\frac{1}{2}$	3	3	$2\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	1	1	1	0
5	4	4	$3\frac{1}{2}$	3	3	$2\frac{1}{2}$	2	$1\frac{1}{2}$	1	1	0
6	5	5	$4\frac{1}{2}$	4	$3\frac{1}{2}$	3	$2\frac{1}{2}$	2	$1\frac{1}{2}$	1	$\frac{1}{2}$
7	6	6	$5\frac{1}{2}$	$4\frac{1}{2}$	4	$3\frac{1}{2}$	3	2	2	1	$\frac{1}{2}$
8	7	7	6	$5\frac{1}{2}$	5	4	$3\frac{1}{2}$	$2\frac{1}{2}$	2	1	$\frac{1}{2}$
9	8	$7\frac{1}{2}$	7	6	$5\frac{1}{2}$	$4\frac{1}{2}$	4	3	2	1	1
10	9	8	8	7	6	5	4	$3\frac{1}{2}$	3	2	1
11	10	9	$8\frac{1}{2}$	$7\frac{1}{2}$	$6\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{2}$	4	3	2	1
12	11	10	9	8	7	6	5	4	3	2	1
13	12	11	10	9	8	7	5	4	3	2	1
14	13	12	11	10	9	7	6	5	4	2	1
15	14	13	11	10	9	8	6	5	4	2	1
16	14	13	12	11	9	8	7	5	4	3	1
17	15	14	13	11	10	9	7	6	4	3	1
18	16	15	14	12	11	9	8	6	4	3	2
19	17	16	15	13	11	10	8	6	5	3	2
20	18	17	15	13	12	10	8	7	5	3	2
21	19	17	16	14	12	11	9	7	5	4	2
22	20	18	17	15	13	11	9	7	6	4	2
23	21	19	17	15	13	12	10	8	6	4	2
24	22	20	18	16	14	12	10	8	6	4	2

When the daily variation increases, add for the variation of the declination for the hours in the first column under H; but when the declination decreases, subtract from the declination of the given day at noon; and the sum or difference will be the declination at the given time. Time being reckoned from the noon of the foregoing day.

REMARKS on the TABLE of DECLINATION.

1. This Table is adapted for several successive years; and because there is an alteration of the Sun's declination from any one year, to the same time four years after, therefore, for the better adaption of the table to serve the purpose proposed, the declinations are truly adapted to the years 1780, -81, -82 and -83, to the nearest minute; and, in the extreme years, the error will seldom exceed one minute: Sometimes it will be too much, and at other times too little. This small defect of 1', or if 2', at sea, is of little consequence, when the latitude of the ship is simply required.

2. When the longitude is required to be found by observation, the first thing is to determine your lat. which cannot be done without the decl. The second, is to find the true time, and how much your watch is faster or slower than the sun.

In this long. case, I recommend the use of the decl. in the Nautical Ephemeris, as you must have it; for that year in which you make those observations, for the requisite distances, being there inserted.

T A B L E III.

A TABLE of the Minutes to be applied to the observed Altitude of the lower Limb of the Sun.

App. Alt. of lower Edge of the Sun, the horizontal dip being 4'.	Min. sub. or add. fr. or to the ap. Alt. of the lower Edge of the Sun observed.
from 0 to 5	Subt. 21
5 to 10	ditto 20
10 to 16	ditto 19
16 to 22	ditto 18
22 to 28	ditto 17
28 to 36	ditto 16
36 to 44	ditto 15
44 to 52	ditto 14
52 to 60	ditto 13
from 0 to 1	Subt. 12
to 1 16	ditto 11
to 1 26	ditto 10
to 1 36	ditto 9
to 1 48	ditto 8
to 2 00	ditto 7
to 2 13	ditto 6
to 2 28	ditto 5
to 2 45	ditto 4
to 3 2	ditto 3
to 3 20	ditto 2
to 3 42	ditto 1
to 4 10	— 0
to 4 40	Add 1
to 5 16	ditto 2
to 5 56	ditto 3
to 6 48	ditto 4
to 8 00	ditto 5
to 9 30	ditto 6
to 11 40	ditto 7
to 15	ditto 8
to 20	ditto 9
to 30	ditto 10
to 50	ditto 11
50 to 60	ditto 12

A TABLE

A TABLE* of Refraction, which is to be subtracted from the apparent or observed Altitude of the Sun, Moon, or Star; but to be added to Zenith Distances.

* TABLE IV.

Alt. obs.	Refr.	Alt. obs.	Refr.
0.00	33	2.53	15
0.06	32	3.11	14
0.12	31	3.32	13
0.19	30	3.56	12
0.26	29	4.24	11
0.33	28	4.56	10
0.40	27	5.36	9
0.48	26	6.20	8
0.56	25	7.15	7
1.04	24	8.40	6
1.13	23	10.30	5
1.22	22	13.10	4
1.33	21	17.30	3
1.43	20	25.	2
1.55	19	44.	1
2.07	18	62.	$\frac{1}{2}$
2.21	17		
2.36	16		

TABLE VI.

Height of the eye.	Ap. dip of horizon.	Dist. of horizon.
feet	min.	miles
2	1	1.75
4	2	2.5
9	3	3.7
18	4	5.25
28	5	6.5
41	6	8.0

Ex. What is the refr. of the sun, moon, or star, observed at $5^{\circ}.20'$ alt.? By the rule, the diff. between the obs. alt. and the next greater, is $16'$. As $40' : 60'' :: 16' : 24'' - 9'.00''$

The refr. for $5^{\circ}.20'$ alt. is $9'.24''$

* By mean refr. is to be understood the refr. of a celestial object, seen through a middle state of the air; for if the air be more dense, the refr. will be greater: But if the air be more rare, the refr. will be less. These differences are very material in some observations, where accurate astronomical instruments are used on shore, but at sea, of little or no consequence; especially in our Southern navigation.

Table V. To find the depression of the moon, by parallax; enter the table with the observed alt. under the moon's apparent alt. and against it under the nearest minute of horiz. parallax, is the parallax of the moon in alt. which must always be added to the alt. observed.

Note. In Table III, are the results of the sun's half diameter, and of Tab. IV, VI.

TABLE

TABLE V.

A TABLE of Parallaxes of the Moon in Altitude.

Moon's ap. alt.	Moon's Horizontal Parallax.			
	54	56	58	60
0	' "	' "	' "	' "
5	53.47	55.47	57.47	59.46
10	53.11	55.09	57.07	59.05
15	52.09	54.05	56.01	57.57
20	50.45	52.37	54.30	56.23
25	48.56	50.44	52.34	54.23
30	46.46	48.30	50.14	51.57
35	44.14	45.52	47.30	49.08
40	41.22	42.54	44.26	45.58
45	38.11	39.36	41.00	42.25
50	34.42	36.00	37.17	38.34
55	30.59	32.07	33.16	34.25
60	27.00	28.00	29.00	30.00
65	22.49	23.40	24.30	25.21
70	18.28	19.09	19.50	20.31

T A B L E VII.

A TABLE of the time to be added to 6 hours, when the latitude and declination are of the same name; but to be subtracted, when they are of different names: The sum, in the first case, or diff. in the second, will be the time of sun setting, in respect of its center, independent of refraction and dip of the horizon. Suppose the refraction 32', and the dip 4', the sum 36' is the apparent alt. of the sun's center, when in the horizon; or its L.L. 20' above the horizon.

Degrees of Latitude of the Ship, or Place.																					
Sun's decl.	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
0	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'
1	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	5	5	6	6	7	7
2	3	3	4	4	4	5	5	6	6	6	7	8	8	9	9	10	11	12	12	13	14
3	5	5	6	6	7	7	8	9	9	10	10	11	12	13	14	15	16	17	18	20	21
4	6	7	8	8	9	10	10	11	12	13	14	15	16	17	18	19	21	22	24	26	28
5	8	8	9	10	11	12	13	14	15	16	17	18	20	21	23	24	26	28	30	32	35
6	9	10	11	12	13	14	15	17	18	19	20	22	24	25	27	29	31	33	36	38	42
7	11	12	13	14	15	17	18	20	21	22	24	25	27	30	32	34	36	39	42	45	49
8	12	13	15	16	18	19	20	22	24	25	27	29	31	34	36	39	41	44	48	52	57
9	14	15	17	18	20	21	23	25	27	29	31	33	35	38	41	44	46	50	54	59	64
10	15	17	18	20	22	23	25	28	30	32	34	37	39	42	45	49	52	56	61	66	72
11	17	18	20	22	24	26	28	31	33	35	38	40	43	46	50	54	57	1.02	1.07	1.12	1.19
12	18	20	22	24	26	28	31	34	36	39	41	44	47	51	55	59	1.02	1.08	1.13	1.19	1.27
13	20	22	24	26	28	30	33	36	39	42	45	48	51	55	59	64	1.08	1.14	1.20	1.27	1.35
14	21	23	26	28	30	33	36	39	42	45	48	52	55	59	64	69	1.14	1.20	1.27	1.35	1.43
15	22	25	27	30	33	35	39	42	46	49	52	56	60	64	69	74	1.20	1.27	1.34	1.43	1.51
16	24	27	29	32	35	38	42	45	49	52	55	59	64	68	74	80	1.26	1.34	1.41	1.50	2.0
17	25	28	31	34	37	41	45	48	52	56	59	63	68	73	79	85	1.32	1.40	1.48	1.58	2.9
18	27	30	33	36	40	44	48	51	55	59	63	68	73	78	84	91	1.38	1.47	1.55	2.06	2.18
19	29	32	35	38	42	46	50	54	58	63	67	72	78	84	90	97	1.45	1.54	2.03	2.14	2.27
20	30	34	37	41	45	49	53	57	61	66	71	77	83	89	95	103	1.51	2.01	2.11	2.23	2.36
21	32	36	40	43	47	52	56	60	65	70	75	81	88	94	101	109	1.58	2.08	2.19	2.32	2.46
22	34	38	42	46	50	55	59	63	68	73	79	86	93	100	107	115	2.05	2.15	2.27	2.42	2.57
23	36	40	44	48	53	57	62	66	71	77	83	90	98	105	113	122	2.12	2.23	2.36	2.52	3.9
24	37	42	46	50	55	60	65	70	75	81	88	95	103	110	119	129	2.19	2.31	2.45	3.02	3.22
25	39	44	48	53	58	63	68	73	79	86	93	100	108	117	126	136	2.26	2.39	2.54	3.12	3.36

The meridian altitude of the sun being observed, in a given year, month, and day of the month; to find the latitude of the ship, or place.

1. Correct the observed altitude of the lower edge of the sun, by the minutes against the alt. in (Table III.) then subtract the correct alt. from 90°, and the remainder will be the zenith dist. write S. after it, if the sun was observed to the South of your zenith; but, if observed with your face towards the North, write N. after the true zenith distance.

2. Find the declination for that day; take it out of the table, and correct it, as you require, as directed in Art. 4, 5, 6, 7, p. 92, 93; then observe the following

C A S E I.

When the zenith distance and the declination are of the same name, their difference will be the latitude: And if the zenith distance be the greater, the latitude is of a different name to the declination; but if the declination be the greater, the latitude is of the same name as the declination.

C A S E II.

When the zenith distance and the declination are of different names, their sum will be the latitude, and of the same name as the declination

C A S E III.

For the Greenland Seas.

When the Sun is observed between the Pole and the Horizon, then the Sum of the correct Altitude and the Complement of the Declination will be the Latitude.

Ex. 1. The mer. alt. of the sun's L.L. was observed the 20th of May, 1776, (mer. London)
to be - - $61^{\circ}.43' \text{ S.}$

By Tab. 3. add 12
True alt. 61.55
Z.D. 28.05 S.
Decl. 20.10 N. } Case 2.
Lat. in 48.15 N.

Suppose the

Ex. 3. Mer. alt. observed $86^{\circ}.27' \text{ N.}$
+ $.12$

True alt. 86.39
Z.D. 3.21 N.
Decl. 20.10 N.

By Case 1.—Lat. in 16.49 N.

N. B. L.L. denotes the lower limb of the sun, and U.L. the upper do.

Remark. That the mer. alt. observed under the pole, is the least altitude the sun can have.

But the mer. alt. observed between the equinoctial and the pole, is the greatest the sun can have, that day, in that place.

The sum is the height of the pole above the hor. which is = the lat. in 77.50 N.

Ex. 2. Mer. alt. obs. May 20, 1776, $27^{\circ}.46' \text{ N.}$
By Tab. 3.—add $.10$

True mer. alt. 27.56
Z.D. 62.04 N.
Decl. 20.10 N.

By Case 1.—Lat. in 41.54 S.

Ex. 4. The 1st of June, 1776.

Mer. alt. obs. L.L. $34^{\circ}.11' \text{ S.}$
+ $.10$

True alt. 34.21
Z.D. 55.39 S.
Decl. 22.11 N.

By Case 2. Lat. in 77.50 N.

Ex. 5. The 1st of June, 1776, at 12 pm.
Mer. alt. of L.L. of the Sun $9^{\circ}.54'$
add 7

True mer. alt. 10.01 N.
Co-decl. 67.49 N.

Rule 1. To find the rising or setting azimuth. As the cos. of the lat. : R :: s, decl. to the cos. of the azimuth; or, by inversion, R : sec. of the lat. :: s, decl. : cos. of the azimuth; which azimuth must be reckoned from that point of the horizon, of the same name with the declination: *i. e.* when the declination is S. reckon it from the South; but when the declination is N. reckon it from the North point of the horizon.

P R O B-

Also that co-ar. denotes complement arithmetical. See Note in p. 26 and 27. Co-lat. for the complement of the latitude, and co-alt. for complement of altitude; decl. for declination; Z.D. for zenith distance, or co-altitude; refr. refraction, and parx. for parallax.

P R O B L E M I.

What amplitude will the sun have at rising and at setting the 24th of January, 1780, in the lat. $48^{\circ}.30' N.$?

By the Table in p. 91, the sun's declination is $19^{\circ}.13' S.$

By Table in p. 97, the sun rises $93'$ after 6 h. that is, at 7 h. 33 m. }
 which is $4\frac{1}{2}$ h. before the 24th day at noon, and in Table II. under } $0.03'$
 $14'$ daily variation, and against $4\frac{1}{2}$ h. is 3m. add and subtract

The decr. added gives declination at rising $19.16 S.$
 Subtracted gives the decl. at setting $19.10 S.$

By Art. 1, p. 90. As cos. lat. $48^{\circ}.30' = 9,82126$

: rad. $10,$

:: s, decl. $19.13 S. \quad 9,51738$

: s, tr. amp. $E. 29.47 S. = 9,69612$ rif. az. $S. 60^{\circ}.13' E.$ which is $N. 119^{\circ}.47' E.$

Magnetic amp. $E. 6.40 S.$ or the obs. az. $S. 83.20 E.$ which is $N. 96.40 E.$

Art. 4. p. 90. Var. $23.08 E.$ By Art. 5, the var. $23.07' E. \quad 23.07 E.$

But the true declination at sun rising under the meridian of Greenwich, is $19^{\circ}.16' S.$ and at setting, is $19^{\circ}.10' S.$ Now to find the rising and setting azimuths.

As cos. lat. $48.30 = 9,82126$ again $9,82126$

: R :: s, decl. $19.16 = 9,51847$ s, of $19.10 \quad 9,51603$

: cs, of the rising az. $60.08 = 9,69721$: cs, of $60.18 \quad 9,69553$ setting az. $60^{\circ}.18'$

Whence it appears, that the rising az. is $5'$ less, and the setting az. $5'$ greater, than that computed with the noon declination.

P R O B L E M II.

What rising az. will the Sun have the 20th of November, 1786, at $1^{\circ}.10' S.$ of the Cape of Good Hope?

C. G. Hope, lat. $34^{\circ}.30' S.$

Add $1.30 S.$

Lat. in $36.00 S.$

Sun's decl. at noon, (mer. Greenwich), $19^{\circ}.48' S.$

The mer. of the ship is $18^{\circ}.40' E.$

which converted into time, is 1 h. 15 m. nearly.

Time of rising is 5 A.M. which is 7.00 before noon.

Subt. as by Art. 6, p. 92, gives the time to noon at Greenwich 5.45 this gives $03'$ by

Table 2, p. 95.

Therefore the true decl. at rising is $19^{\circ}.45' S.$

Ditto at setting is $19.51 S.$

Hence, As R : sec. of $36^{\circ}.00' = 10,09204$

:: s, decl. $19.45 = 9,52881$

: cs. rising az. $S. 65.19 E. = 9,62085$

Which gives $N. 114.41 E.$ the true az.

Suppose the magnetic az. $N. 135.56 E.$

The var. $21.15 W.$ By Note 2, Art. 5.

P R O B L E M III.

Suppose a Ship to be in the Chinese sea the 1st of March, 1787, in the lat. $21^{\circ}.20' N.$ lon. by account $120^{\circ} E.$ What will be the sun's az. at setting. By Table VII, p. 97, against the sun's decl. that day at noon at Greenwich, which is $7^{\circ}.31' S.$ (daily decr. $23'$), and under lat. 22° is $12'$, these subtracted from 6 h. leaves 5 h. 48 m. the time of sun setting. Now the lon. 120° , converted into time by Art. 5, p. 92, is 8 h. to be subtracted from the time of sun's setting at the ship, (6 h. 12 m.) gives the time at Greenwich 1 h. 48 m. before midnight

midnight of the foregoing day. Or February 28th, at 10 h. 12 m. afternoon; to which time find the decl. Thus February 28th, decl. at noon $7^{\circ}.54'$ S. and by Table II, for 10 h. under H. (which column answers to 24 m. of daily variation), is 10 m. and under 22 m. is 9 m. therefore I take $9\frac{1}{2}$ m. for the decr. of declination, these being subtracted from $7^{\circ}.54'$ leaves $7^{\circ}.44\frac{1}{2}'$ the true decl. at the time of observation at the ship. Cast off the $\frac{1}{2}$ m. and then:

As R : fec. lat. $21^{\circ}.20'$ —0,03083
 :: s, of the decl. 7.44 —9,12982
 : cs. of the az. S.81.42 W.—9,15975 By Art. 5, p. 90, Note 4.
 Which is N.98.18 W. ————— By the Remark in Art. 5, Note 2.
 Suppose the mag. az. N.81.45 W.
 Var. 16.33 W. By Art. 5, p. 90. Note 3.

PROBLEM IV.

In the lat. 18° N. lon. 72° W. the 4th of June, 1776, the sun was observed to set (by the compass) N. 74° W. What is the Variation?

Thus 72° lon. = $4^{\circ}.48'$	Decl. at noon $22^{\circ}.33' \text{ N.}$	Daily Alteration $6'$ increasing.
Sun set at 6.30	For $11 \text{ h. } 18' + \quad 3$	Cof. lat. $18^{\circ}.00 - 9,97821$
Time at Greenwich <u>11.18</u>	True decl. <u>22.36 N.</u>	R + s, decl. $22.36 - 19,58466$
		Cos. of az. <u>$\text{N. } 66.10 \text{ W} - 9,60645$</u>
		Obf. az. <u>$\text{N. } 74.00 \text{ W}$</u>
		Var. <u>7.50 E.</u>

To find the TRUE AZIMUTH of the Sun, Moon or Star.

IN order for finding the true azimuth of the sun, you must know the latitude of the place, also the declination and the altitude of the sun.

Art. 1. When the lat. and the decl. are of the same name ; the decl. taken from 90° leaves the dist. of the sun from the elevated pole, or polar dist.

2. When the lat. and the decl. are of different names, the decl. added to 90° gives the polar distance.

Rule 2. A GENERAL RULE to find the **TRUE AZIMUTH** at all Altitudes.

Add to the polar dist. the co-lat. and co-alt. from half the sum, take the co-lat. and co-alt. separately, and note the remainders; then to the sines co-ar. of the co-lat. and co-alt. add the sines of the two remainders; and half the sum of these log. sines, will be, the sine of half the required angle of azimuth; which degrees and minutes being doubled, will be the azimuth from the elevated pole of the same name as the latitude, or from the point of the horizon of the same name with the latitude you are in.

Ex. 1. In the lat. $51^{\circ}.30'$ N. the 4th of June, 1776, the sun's decl. $22^{\circ}.33\frac{1}{2}'$ N. at 4 P.M.
Polar dist. $67.26\frac{1}{2}$

True alt. of the sun $33^{\circ}.33'$. Azimuth obs. $N. 72^{\circ}.21' W.$ to find the Variation.
Polar dist. $67^{\circ}.26\frac{1}{2}'$

Co-lat.	38 .30	—	0,20585	
Co-alt.	56 .27	—	0,07915	
Sum	102 .23 ¹ ₂		9,83133	
$\frac{1}{2}$ Sum	81 .12		9,62186	
Remainders {	42 .42		19,73819	Sum.
	24 .45		9,86909	Half.

Half, is s, of $47^{\circ}.43'$, which being doubled, is the true az. N. 95.26 W.

Magnetic az. N. 72.21 W. the mean of 4 azimuths.

Var. 23 .05 W. By Art. 5, p. 90, note 3.

Ex. 2.

Note. The true azimuth of the moon or star, are to be found in like manner.

Ex. 2. In the lat. $49^{\circ}.40' N.$ when the declination was $10^{\circ} S.$ and the sun's alt. $18^{\circ}.34' S.E.$ the azimuth by the compass was $S. 24^{\circ}.10' E.$ What was the variation?

Which is $N. 55.50 E.$

Polar dist.	$100^{\circ}.00'$	
Com. of lat.	40.20	$-0,188939$
Com. of alt.	71.26	$-0,023213$
The sum	211.46	$9,959195$
Half the sum	105.53	$9,752576$
Diff.	65.33	$19,923923$
Do.	34.27	$9,961961$
		s, of $66^{\circ}.22'$, which doubled
		is the true az. $N. 132.44 E.$
		Obs. az. $N. 155.50 E.$
		Variation <u>$23.06 W.$</u>

In the lat. $48^{\circ}.40' N.$ the sun's alt. $32^{\circ}.03' S.W.$ when the declination was $5^{\circ} N.$ the azimuth by the Compass was observed to be $S. 74^{\circ}.20' W.$ What was the var. of that compass?

By computing I find the true azimuth to be $S. 56^{\circ}.13' W.$

Its supplement is the az. from the N. which is $N. 123.47 W.$

Magnetic az. by compass $N. 105.40 W.$

By Art. 3, p. 90, The variation $18.07 W.$

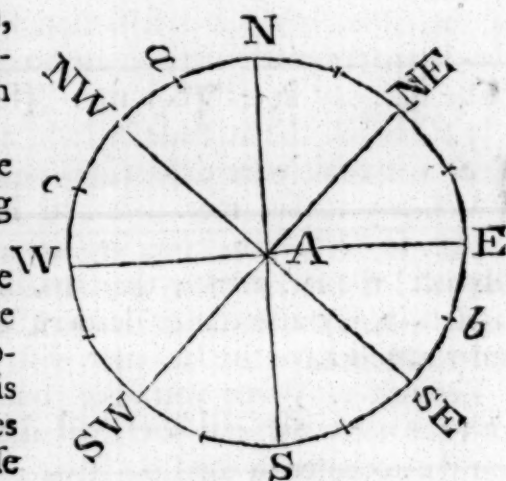
Let the annexed figure represent the plane of the horizon, round the ship at A; the North and South points of the meridian, are marked N and S; the East and West points, with E and W.

Suppose a ship to sail from A, her course N.E. with the wind at N.W. (that is, blowing from that position or bearing of *a*, towards A), 6 points from the course of the ship.

In this case, it is evident, that the wind blows against the left or larboard side of the ship, which will cause her to make Way through the water some quantity more from the N. towards the E. which is called leeway; and that quantity is to be estimated in $\frac{1}{4}$ points; and so much as the ship makes leeway must be added to the course steered, to get the course made by the Ship.

But if the wind was at *b* (E.S.E.); then the leeway made on the N.E. course would be towards the meridian, and must be subtracted from the course steered, because the ship would make her way through the water, that quantity nearer to the North: And the like of all other cases.

If the compass you are steering by, vary two points W. and you are sailing W. by it, the course made will be W.S.W. Hence, if you want to make a W.S.W. course, you must steer by the compass W. that is, reckon W. variation to the right, E. variation to the left, of the course to make, and you will have the course to be steered, save the leeway to be allowed.



The METHOD of working DAY WORKS at Sea.

TO CORRECT the COURSES a ship has steered, by the LEERWAY and the VARIATION.

Art. 1. **W**HEN a ship sails on a wind that is 6 or 7 points from it, she will make leeway; and the less way she makes through the water, the more lee-way she will make.

2. The quantity of the lee-way may be obtained by observing the angle made between the direction of the course steered (or keel of the ship) and the ship's wake, which is to be reckoned by points and $\frac{1}{4}$ points of the compass.

C c

3. When

3. When the course the ship is steered, is between the meridian and the wind, the lee-way must be taken from the course; but when the wind is between the meridian and the course, the lee-way must be added to the course steered.

4. If the variation be West, reckon it towards the left hand; but if it be East, towards the right. N. B. When the lee-way and the variation are both towards the right, or both towards the left hand, then their sum must be applied to the course; but when they are contrary ways, their difference must be added or subtracted to or from the course, and you will have the course corrected. [See p. 49.]

5. To find the course and distance made good from day to day: Find the lat. and dep. made that day, in the Traverse Table, (against each other); and at the top, if the lat. be the greater, but at the bottom, if the dep. be the greater, will be the course made good; also against them, will be the distance made, in distance column.

6. To find the difference of longitude a ship has made in a day; or to find the longitude made from day to day.

Note 1. To find the middle latitude from day to day.

When the latitude made the last 24 hours, is of the same name as the latitude the ship was in the foregoing day; then add half the latitude made, to the latitude the ship was in the foregoing day (at noon), and the sum will be the middle latitude; but if the latitude made be of a contrary name to that of the ship the foregoing day, then subtract half the lat. made, and the difference will be the middle latitude.

Note 2. Find in the Traverse Table, the nearest degree of the middle latitude (at the top of the table, when it is less than 45° ; but when it is greater, at the bottom); and then find the departure made the last 24 hours, in lat. column, and against it you will find the longitude made that day in dist. column. [See p. 28 of Geography.]

7. To find the latitude in, and also the meridional distance and longitude made, from the place you took your departure.

When your lat. mer. dist. and lon. made, the last 24 hours, are of the same name with the lat. in, &c. the foregoing day; then add to the lat. in, the foregoing day, (otherwise subtract) the lat. made; the sum, in one case, &c. and the difference, in the other, will be the lat. in, by account or dead reckoning: Do in like manner with mer. dist. and lon. made, and you will have the lat. mer. dist. and lon. required. [See Journal following.]

Remark 1. When you take your departure from any cape of land, you take its bearing with the compass, and you then assume its distance from the ship; that bearing and distance you are to enter in the Log-Book; and when you work the traverse of the day's work, take the opposite point that the land bore from the ship, correct it by the variation, (if any), and make it the first course, from such cape; and take the assumed distance for the distance of that course.

The Journal is to be kept from the last cape or headland you can see, whose lat. and lon. are known; which, in sailing from the British Channel to the Southward, is generally the Lizard, (but in sailing to the N. West, the Land's-End), from which place, you are to find each day at noon, the distance the ship is from it, and how it bears.

3. To mark the place in your sea chart the ship is in, and then note the courses you must steer the following day, and the distances on each; so as to make good the most proper course for the ship, according to winds, weather, rocks, shoals, &c.

4. Write in your Log-Book all the capes, headlands, ships, sloops, &c. that you pass, with every other material circumstance that happens.

5. When you make an island, or any Land, write down its bearing, and how it appears in comparison with something generally known; what land you take it for, &c. together with its latitude and longitude by your account: And if it be land whose latitude and longitude are known, you are then to keep your account from it; and so from cape to cape, and land to land, in sailing from one port to another.

6. The

6. The place of a ship to be marked in the chart from day to day, should be done from your Journal of your lat. in, and mer. distance, in plane charts; and by lat. and lon. in Reduced and in Mercator's Charts, and not by that erroneous method of course and distance, sometimes deduced from the traverse of 10 or 12 courses and distances; none of which can be expected to be true, in seas or channels, or in the ocean within 4 or 5° of land, by reason of the sets and drifts of the tides.

7. The latitudes of ships are frequently observed in seas, and along the coasts; which lat. will generally differ from that by account, of your day's work; the lat. by observation, is to be depended upon; and the mer. dist. or lon. must be taken with such correction as you can assign a sufficient reason for, otherwise take it as deduced from the day's work, without any correction; for to make a correction of mer. dist. or lon. you are to view your chart, and to consider how the flood and ebb tides have acted upon the ship, together with other circumstances. These things duly considered by a person of sound judgment and experience, will enable him to make a good correction; but as to young commanders, I advise them, to take the latitude by observation, and the mer. dist. or lon. by account, and so lay down the place of his Ship from day to day; and never correct the lon. but by experience, and by lon. observations, well made and computed, made with accurate instruments: [Of which see my Treatise on the Longitude, price 2s. 6d. sold by J. Nourse, Strand].

Note in Atkinson's, Wilson's, Patoun's Crosby's, and in many other authors of later date, are general rules and cases for the correcting of reckonings upon the principles of similar triangles (as if they had been sailing in a fish pond, where no tides can act). In the latter end of this Treatise, I propose to shew the absurdity of that method of correction; and in various circumstances, if such corrections had been used, the account would have been much worse than by having no correction at all.

Having ruled your Log-Book, and marked the columns, H. for hours, K. for knots, HK. or $\frac{1}{2}$ K. for half knots; or F. for fathoms, &c. as per Log-Book following: In the same line you may write, Remarks on such day, month and year.

Remark 1. That the commanders of ships end their day account at noon. And the hours after that day at noon, go on to the reckoning of the next day at noon; and transactions are entered in such sea journal, at such an hour P.M. which denotes so many hours after the noon past: And when the time is past midnight, they write the hour that it is in the morning of the approaching noon; and after it, A.M. which denotes the time of the day in the forenoon; and so on till twelve, when they close the account for that day.

Remark 2. That our civil method of reckoning is from midnight to midnight. Our sea reckonings of the day, are from the time after the noon of the foregoing day, which is 12 hours before the civil account of the day; and our astronomical day begins at the noon of the civil day, when the sea journalist ends his day: Thus the seaman reckons his time of 24 hours before or towards his noon; and the astronomer reckons his time from or after his noon; that is, if the civil account be May the 10th, at noon, the astronomer would then write May the 10th, and all remarks after the noon, at hours, minutes, &c. afternoon, till the following noon. But the seaman would write May 11th, for the afternoon hours of the 10th, with P.M. &c. till the 11th at noon came, when he would close his account for that day.

Whence it appears, that the astronomer writes his day, when he begins his account; but the seaman writes his, when his day is ended: Which are their different methods of keeping account of the same absolute time.

OF MEASURING the DISTANCES a Ship SAILS.

This is done by a HALF-MINUTE GLASS, a LOG, and LOG-LINE.

The Half-minute glass contains either sand, or metal filings, and they are made to run out in different lengths of time; some in 14, some in 15 seconds, others in 28, and some in 30 seconds; which different times are adapted to the different distances between the knots of the log-line.

Log-

Log-lines are made of different lengths, from 50 fathoms to 150, to serve for different ships and vessels.

The 14 and 15" glasses, are used when ships sail at the rate of 10 knots or more in half a minute, and in high seas and stormy weather; the log then being very troublesome to get in, which is the reason these glasses are used.

To divide the log-line into knots and fathoms. Thus: Find the proper distance between each knot by this general rule. Divide the seconds of time that the sand glass is in running out, by 4 (or any other measure of time in seconds), the quotient will be the distance in fathoms; which will be the best adapted for use at sea, as appears by the experience of several able mariners and mathematicians. Commanders, in general, divide their log-line in fathoms of 6 feet each; others divide the line into fathoms 5 feet each; reckoning 50 feet to each knot; so that, in casting up the log, in the column of fathoms, each fathom answers to 1, or $\frac{1}{10}$ of a mile, and ten fathoms make 1 knot: But experience hath shewn to us, that reckonings kept by this 50 feet line to the knot, generally make the ship a-head of the reckoning; which is much worse than the reckoning a-head of the ship.

A glass that runs out in 32" requires 8 fathoms to a knot, 6 feet each.

And in proportion, a glass which runs 30" requires $7\frac{1}{2}$ fathoms, or 45 feet, for each knot.

28	7	or 42
26	$6\frac{1}{2}$	or 39
24	6	or 36

See p. 35, 36 of Plane Sailing: Notwithstanding the true distance of a knot to be 50,6 feet. See also p. 22 of Geography.

The reason for making such allowance of $5\frac{6}{10}$ feet in each knot, for a 30" glass, is for the way the log is found to make after the ship.

Those commanders who would keep a good account of the way a ship makes, should be very circumspect in heaving the log, and in giving the ship her true course steered and dist.

OF HEAVING the LOG.

Let two men hold the reel between them, and another the half-minute glass; the officer of the watch with the log in his hand, and the stray line (10 or 12 fathoms) drawn off the reel; he then throws the log over the stern of the ship; and when the red rag, at the end off the stray line, goes over the rail, he calls, turn; the man turns the half-minute glass; and when it is run out, he cries, stop; the man stops the reel from running round, and in course it stops the line; the officer then looks at the last knot which came off the reel, and it shews him how many knots are gone off (by the number of strings tied to the knot), and the fathoms from that knot to the reel, are the odd fathoms to be wrote down, which the officer adjusts according to the mean rate of her going for that hour, according to the best of his judgment. Note. The stray line is the length of line allowed for the log to be out of the eddy of the wake of the ship.

To find the Number of Seconds that a Glass is in running out.

Take a piece of lead (or other piece of heavy metal) about an ounce in weight, (a musket ball) in form either spherical or conical nearly; fasten a piece of fine packthread, or of silk, to it, and hang it by a loop, upon a nail, and so that the measure between the centre of the plummet and the nail be 39 inches, or $39\frac{2}{10}$; then draw it 5 or 6 inches from its perpendicular, and let it swing, and turn your glass at the same time, when you let it go; count the number of swings that it makes in the time the glass is running out, and they will be the seconds required.

For all simple pendulums that are 39 inches long, vibrate or swing seconds, each swing being made in a second of time.

Having given the lat. and lon. of two places, to find their bearing and dist. by Trav. Table.

Rule 1. Enter the table with the mid. lat. [Def. 26, p. 35.] and find their diff. of lon. in dist. column; then against it is the dep. in lat. column.

2. Enter the table with the diff. of their latitudes, and with the dep. found by Rule 1, and you will have the course and dist. as in Art. 5, p. 102.

When

When the glass runs out in less time, than that to which the line is adapted, the reckoning will be a-stern; but if it run a longer time, the reckoning will be a-head of the ship.

Note. In hot or dry weather the sand, or filings, will run out in less time than when it is moist and rainy; and between the extremes you may frequently find 2 or 3 seconds: So that a glass that runs out, in dry air, in 30'', will, in moist air, take 31 or 32, and, in extreme moist weather 33''. Suppose your log-line to have $7\frac{1}{2}$ fathoms to a knot, and a 30'' glass, in fine weather; and, when you try the glass at sea, that it runs 32'': What distance must be allowed in making 10 knots and 5 fathoms by such glass. Now since the glass runs longer than its proper time, the log will have run off the reel a greater length than must be allowed for to make it correspond with 120 half minutes in an hour: Hence the distance must be decreased in the ratio of 32 to 30, and so is $10\frac{2}{3}$ to 10 knots, very near.

Suppose the line divided for a 30'' glass, and the glass is found to run only 28'', and in that time the ship makes $9\frac{1}{2}$ knots: What is due to such log? As $28 : 30 :: 9\frac{1}{2} : 10\frac{1}{5}$ miles due to that hour. Suppose the glass 30'', and to be right; and the log-line to be stretched 5 feet in 10 knots; and that we made $11\frac{1}{4}$ knots: What is the true distance to be entered in the Log-Book? As $10 : 10,1 :: 11,25 : 11,4$ miles an hour, nearly. These particulars should be regarded, and allowances made accordingly; otherwise a very great error may arise after a month or more sailing, without such correction.

Another Example to make the METHOD of CORRECTION more evident.

Suppose a glass 28'', and a line 42 feet, or 7 fathoms; and that the line is stretched (by drawing in the log) 4 feet in a knot, one with another: What is due to the hour in which we made 7 knots and 3 fathoms?

Thus, 7 knots and 3 fathoms are 52 fathoms, at 7 fathoms to a knot. If 7 fathoms give 4 feet, 52 fathoms will give 29,7 feet, which call 30; divide by 6, and we have 5 fathoms to be added to 7k. 3f. the sum is 8 knots and 1 fathom for that hour: And so of any other.

Suppose a 28'' glass lengthened to 31'', and a 7 fathom log-line lengthened $2\frac{1}{4}$ ft. in a knot; and that they had sailed by such log-line and glass, 3 days, in which time of bad weather they had differed their lat. 112 m. S. and departed 340 m. W. from the Lizard: What is the correct X lat. and dep.? What lon. has she made? And what lat. is the ship in?

1. As $28'' : 31'' :: 42 \text{ f.} : 46\frac{1}{2} \text{ f.}$ the true length of the knot for such glass.

The ship's line $44\frac{1}{2} \text{ f.}$ which is 2 feet too short for the glass.

Consequently, the ship would appear to make more way than she did make; and her account is thereby a-head of the ship. To rectify the account, remark, that $\frac{4}{2} = 2$, that is, 2 feet is $\frac{1}{21}$ th part of a knot, which 21th part, is what the ship's account is too much; hence from 112' take its 21th part. Thus $21)112(5\frac{1}{2}$, to be subtracted from 112', the remainder is 107', the correct diff. of lat.

And $21)340(16'$, Subtract from 340, the remainder is $324' = 5^{\circ}.24' \text{ W.}$ the

correct merid. dist.

And, from the lat. Lizard 49.57 N.

Take the X lat. made correct 1.47 S. Lon. made.

Remains the lat. in 48.10 N. $3^{\circ}.14' \text{ W.}$

Suppose that between the running of the glass and the running out of the line there be $5\frac{1}{2}$ feet, that the ship got a-head (per knot) of her reckoning, by using a line of 8 fathoms to the knot, and a 30'' glass.

Now $5,5)48,0(8,7$ the part of every account that the ship has got a-head of her reckoning; to rectify the following account.

Being 10 days at sea in bad weather, off the Azores, making for the British channel, in which time we had made $7^{\circ}.40' \text{ N.}$ and differed our lon. 20° E. by the account: What is the correct X lat. and X lon.? Thus $8.7)7^{\circ}.40'(53'$ nearly. And $8.7)1200,0(138'$, error in lon.

	60	
	460.0	
From $7^{\circ}.40' \text{ N.}$	and from $20^{\circ}.00' \text{ E.}$	
Take .53	and 2.18	the correction.
X of lat. 6.47 N.	and of lon. 17.42 E.	correct.

D d

ALLOW-

ALLOWANCES to be made for LEE-WAY that Ships make when sailing on a Winl.

1. When a ship is close hauled, all sails set, with a gentle sea, allow half a point.
2. When it blows a gale, that the small sails are taken in, allow 1 point; and if a high sea, $1\frac{1}{2}$ point.
3. When it blows so that the top-sails are close reefed, allow 2 points.
4. When it blows so hard that both top-sails are taken in, together with a high sea, allow 3 points.
5. When the fore-sails are furled, and the ship tries under a main-sail and a mizen, allow 4 points.
6. When the ship tries under a main-sail only, allow 5 points.
7. When both the main and fore courses are taken in; or when she is tried under a mizen; allow 6 points.
8. When the ship lies a-hull, that is, with all her sails furled, or all sails handed, her way is 1 point before the beam; therefore allow 7 points lee-way.
9. When the wind has blown hard, and raised a high sea from that quarter, and changed to another quarter; and the ship steered the same course, and sailing close hauled upon the other tack; the lee-way then made by the ship will be greatly lessened by reason of the swell of the sea driving against the lee-side of the ship. In all these cases respect must be had to the state of the sea.
10. The allowance of lee-way may be obtained with greater certainty, by setting the ship's wake, by a compass. The commanders of some ships have compass cards nailed on the rails of the aft part of the ship, for that purpose.

I shall now shew the form of the Log-Book and Journal, with the use of a Plane Chart, and how to assign the place of a ship in it, as often as occasion may require. 1st. From the Spurn (at the mouth of the river Humber) to the Naze of Norway; and from thence to the Scaw, through the Sound, Baltick and Gulph of Finland, to Cronstat, for St. Petersburg.

A LOG-BOOK and JOURNAL of a VOYAGE in the Swift, Capt. Roberts, for Petersburg.

The first Day's Log-Book.					Remarks on Saturday the 11th of May, 1776.																		
H.	K.	$\frac{1}{2}$ K.	Courses	Winds.																			
2																							
4	We	took	our de-	parture	from the Spurn, it bore S.W. distance 3 leagues.																		
6	7	0	NEbE.	NW.	Fair but cloudy.																		
8	6	1			By Art. 1. p. 49. The opposite point to the bearing of the																		
10	6				Spurn, when we took our departure, is N.E. which being cor-																		
12	6				rected by the var. [see p. 49 and 50] gives N.N.E. dist. 9 miles;																		
2	5	1			and the N.E.bE. corrected, is N.E.bN. dist. 129'; which by																		
4	5	1			Trav. Table, gives as in the day's work.																		
6	6	0			Lat. of the Spurn $53^{\circ}.30' N.$																		
8	6	1			Diff. of lat. made $1.55 N.$																		
10	7	1			Lat. in by account $55.25 N.$																		
12	8	0			Variation 2 points W.																		
Per log 129 miles.																							
Made good this day.																							
					<table border="1"> <tr> <td>Course made.</td><td>Dist.</td><td>Lat. N.</td><td>Dep. E.</td><td>lat. in by obs.</td><td>$55^{\circ}.20' N$</td></tr> <tr> <td></td><td></td><td></td><td></td><td>by acc.</td><td>55.25</td></tr> <tr> <td colspan="5">N. $33^{\circ} E.$ $138'$ $115.5 = 1^{\circ}.55'$ $175 = 1^{\circ}.15'$ mer. dif. made</td><td>$1.15 E$</td></tr> </table>	Course made.	Dist.	Lat. N.	Dep. E.	lat. in by obs.	$55^{\circ}.20' N$					by acc.	55.25	N. $33^{\circ} E.$ $138'$ $115.5 = 1^{\circ}.55'$ $175 = 1^{\circ}.15'$ mer. dif. made					$1.15 E$
Course made.	Dist.	Lat. N.	Dep. E.	lat. in by obs.	$55^{\circ}.20' N$																		
				by acc.	55.25																		
N. $33^{\circ} E.$ $138'$ $115.5 = 1^{\circ}.55'$ $175 = 1^{\circ}.15'$ mer. dif. made					$1.15 E$																		

Log-

Log-Book, the 2d Day.				Remarks, May the 12th, 1776.			
H. K.	$\frac{1}{2}$ K.	Courses.	Winds.				
2	8	1	ENE. NNW.	Dark, cloudy weather, blows hard.			
4	8	1	108' on this course.				
6	8	1					
8	9	1					
10	9	1					
12	9	1	EbN. NNW+N.	Some Thunder and Lightning.			
2	9		111' on this course.				
4	8	1					
6	9	0	Blows very hard with a high sea.				
8	9	1	Mer. dist. Y.D. 1°.15' E.				
10	9	1	Made - 2.49 E.				
12	10		Sum - 4.04 E.				
Per log 219 miles.				Variation 2 pts. W.			
Course made.		Diff.	Lat. N.	Dep. E.	Lat. in yesterday 55°.20' N.		
					Diff. of lat. - 2.18 N.		
Made good this day.		N. 51° E.	218'	138' = 2°.18'	169' = 2°.49'	Lat. in by acc. 57°.38' N.	
						Mer. dist. - 4.04 E.	

REMARKS on the foregoing Day's LOG-BOOK.

1. The method to cast the distance failed by the log on each course. First, add together the knots failed on the course, double them; and then add the half knots of that course to the sum, and you will have the miles failed on that course.

2. When you have failed on several courses, the same day, draw a line in the log-book under the hour, and distances failed between the last course failed and the following, and add up the log of each course, and write the distance under the course it was made, as are in the second day's log. Thus under E.N.E. is 108', and under E.bN. is 111', the distances on them courses, which courses corrected by the variation, are N.E. and N.E.bE. those worked by Traverse Table, give the course made good N. 51° E. 218' diff. of lat. 138', and dep. 169'; which applied to the lat. in, and mer. dist. of the foregoing day, gives the lat. in, this day at noon, 57°.38' N. and mer. dist. made 4°.4' E. from the Spurn.

Log-Book the third Day.				Remarks the 13th of May, 1776.					
H. K.	$\frac{1}{2}$ K.	Courses.	Winds.						
2	9	1	EbE.	NWbW.	Cloudy and a high sea.				
4	9	0							
6	8	1							
8	9								
10	9								
12	8	1	NNW.						
2	8								
4	8								
6	9	1							
8	9	1							
10	9								
12	9	1	NbW.						
Per Log 212 miles.				Made good	Diff.	X lat. N.	Dep. E.	Mer. dist. yesterday	4°.04' E.
								Made	2°.56' E.
				NEbE.	212	118' = 1°.58'	176' = 2°.56'	Total made	7.00 E.

The reckoning is greatly a-head of the ship.
See Remark 5th following.

Log.

Note, Y.D. stands for yesterday.

H.	K.	$\frac{1}{2}$ K.	Courses.	Winds.
2	$\frac{3}{4}$	1	$E\frac{1}{2}N.$	N.
4	7		EbS.	
6	9	1		
8	9			

Remarks, May the 14th, 1776.

At 1 P.M. we made the Naze, it bore $N.\frac{1}{2}W.$ dist. 8 leagues, we altered our course and steered E.bS. to make the Scaw.

At half past 7 we made the Scaw, and we continued our course till it bore S.W. we then altered our course and sailed several courses till we passed the Sound and the Baltic, we then steered so as to make good our courses, as by the chart, till we made Bornholm; we then sailed (var. allowed) $E.N.E.$ 160 miles; $N.bE.\frac{1}{2}E.$ 180; then $N.E.$ till we got into lat. $60^{\circ}.20'N.$ then our courses and distances to make good, were $N.E.$ 105'; $E.\frac{1}{2}N.$ 164'; $E.\frac{3}{4}S.$ 68'; $E.N.E.\frac{3}{4}E.$ 28'; $E.$ 17'; $EbN.$ 12'; $N.N.E.\frac{1}{2}E.$ 7'; and $E.\frac{3}{4}N.$ 36'; and then arrived at Cronstat. Winds and weather proved favourable all the time we were in passing the Cattigate, Sound, Baltic, and Gulf of Finland.

REMARKS on the foregoing VOYAGE. The Var. being between 2 and $2\frac{1}{4}$ pts. W. Course to be steered.

1. From the Spurn to the Naze, is $N.43\frac{1}{2}^{\circ}E.$ 350 miles. Mer. dist. $241' = 4^{\circ}.01'E.$ $E.N.E.$
2. From Flambro-head to do. $N.44\frac{1}{2}^{\circ}E.$ 300 miles. Mer. dist. $217 = 3.37E.$ $E.N.E.$
3. From Harwich to do. $N.30\frac{1}{2}^{\circ}E.$ 400 miles. Mer. dist. $202 = 3.22E.$ $N.E.\frac{3}{4}E.$
4. Suppose the ship to be S. from the Naze 6 or 7 leagues, then your course to make, to } 60 miles. Steer with a fair wind }
pass the Scaw, is $E\frac{1}{2}N.$ about } abast the beam $E.S.E.$ or - } $E.S.E.\frac{1}{2}E.$
5. The reckoning was 2° a-head of the ship, and 16'; which great difference must be attributed to various causes: The principal, I may say, were heavy gales of wind, high seas, and Southerly sets by the current, which had drove us greatly to the Southward; these, together with bad steerage, and error of giving the ship's way through the water by the log. In all such circumstances, I would advise the mariner to steer his proper course till he make land, and then find the error of his reckoning, for his future information and experience.

R E M A R K S.

1. The Cattigate is contained between Denmark and Norway, generally called the Sound, from the Scaw to Rugen I. When you come into the neck of the Sound, off Elfinore, you must pay tribute to the King of Denmark.
2. The Baltic, or East Sea, is contained between Schonen of Norway, Moon I. of Denmark, on the West; Rugen I. of Mecklinburg, and the North coast of Pomerania on the South; (Bornholm I. is in the Western part of the Baltic). Dantzick and Koningburg are on the S.E. coast; the coast of Courland on the East, and the West end of the Gulf of Finland; the Gulf of Bothnia on the North; Stockholm, Calmer, and part of the S.E. coast of Sweden, are its N.W. bounds.

To find the Bearing and dist. between the Ship and Place you took your dep. from. By Tr. Tab.

Rule 1. Find the diff. of lat. of the ship, and the Place, in miles, in lat. col. find also the mer. dist. (made from the place you took your dep. from), in miles, in dep. col. and at the head of the table, if the X lat. exceed the dep. but at the foot, if it be less, you will have the bearing in degrees; also against the X lat. and dep. you will have the dist. in the col. of distance.

Rule 2. To find the bearing and dist. between the ship and any other place whose lat. and lon. are known. First, Enter the table with the nearest degree of mid. lat. between the ship and the place, and with their diff. of lon. in dist. column; and you will have the dep. in lat. col. Secondly. Enter the table with the diff. of lat. and that dep. and you will have the bearing in degrees at the head or foot of the table; and the dist. in its col. as in other cases. [See p. 47, 48, 49, of Plane Sailing].

A TABLE

A TABLE of the True Course, Distance, and Course to be steered, by a Compass which varies 2 points W. from the Downs, through the British Channel to Sea. A ship in the Downs to fail;

True Course.	Course to steer.	Dist. miles.	Bearing and distance from capes, headlands, or highlands, islands, rocks, light-houses, &c.			
				By the Chart.		Miles.
S.	SSW.	8 $\frac{1}{2}$	S. Foreland, by compass, WNW.	is W.	dist.	2
SW.	WSW.	20	Dengenefs, NNW.	is NW.		3
SWbW $\frac{1}{4}$ W.	WbS $\frac{1}{4}$ W.	32	Beachyhead, — NNE.	is N.		9
WSW $\frac{1}{4}$ W.	W $\frac{1}{4}$ N.	62	Dunnofe, — N.	is NNW.		15
			St. Catherine's Point, NbW $\frac{1}{2}$ W.	is NWbN $\frac{1}{2}$ W.		16
		33	Peveral Point — NbE.	is NbW.		24
			C. la Hague, — SWbS.	is SbW.		26
		26	Bill of Portland, — NbE $\frac{3}{4}$ E.	is N $\frac{1}{4}$ W.		26
			Alderney I. — S $\frac{1}{4}$ E.	is SSE $\frac{1}{4}$ E.		21
			Caskets, (rocks) — SbW $\frac{3}{4}$ W.	is S $\frac{1}{4}$ E.		19
		12	Guernsey I. — SbW.	is SbE.		26
		38	The Start, — NbE.	is NbW.		19
		27	Eddystone Lighthouse, NNE.	is N.		24
			Ramhead, — NNE $\frac{1}{2}$ E.	is N $\frac{1}{2}$ E.		36
		58	The Lizard, — NE.	is NNE.		30
			Land's-end, — N $\frac{1}{4}$ E.	is NbW $\frac{3}{4}$ W.		36
			Ufhant I. — SbW.	is SbE.		58
	Total	316 $\frac{1}{2}$				

The British Channel 290 Miles from the S. Foreland to the Lizard; to sail in the fair way 310.

Note. That Ufhent and the Lizard bear N. and South of each other, distance 28 $\frac{1}{2}$ leagues, which is 85 miles = 1 $^{\circ}$.25'; but the fair way of the channel between these places, is at one third of the width of the channel from the English coast, which is in the lat. 49 $^{\circ}$.30. N. If you sail in the mid-channel till you make the Start, you will have the tide to set you towards the French Coast; for, in some parts, it sets S.E. and S.S.E.

Oct. 15, 1775, at Anchor in the Downs. At 2 P.M. hove up, and made sail, Wind N.N.W.

At 5 P.M. S. Foreland bore W.bS. 2 miles. We steered W.S.W.

At 8 P.M. S. Foreland light N.E. $\frac{1}{2}$ E. about 3 leagues. At 7 P.M. tide from the N. till 12.

At 12 P.M. Dengenefs light, E.bN. 7 or 8 miles Channel tide flowed till 7 A.M.

16th, At 4 A.M. the high land of Fairlee bore N.E. 5 or 6 miles. Course failed W.S.W.

At 8 A.M. Beachyhead bore W.bN. 4 or 5 miles. About 90 Sail in sight.

At noon, Beachyhead bore N.N.E. 3 leagues. Course all this day W.S.W.

At 4 P.M. do. bore N.E.bE. 3 or 4 leagues. } The 17th Day in the next page,

At 6 P.M. do. bore N.E.bE. 4 leagues. } for reasons given in p. 103.

Remark. In the following Journal are found the bearing and distance of the Lizard from the ship, for several days, by Rule 1, in p. 108: And the bearings and distances of the nearest land, &c. from the ship, by Rule 2. But as neither the bearing or distance of the Lizard, are of the least use, when you are continually going from it, only those parts of land, rocks, sands, &c. that you are approaching, the bearings and distances of such places are of the greatest consequence, especially in bad weather; so that you may sail courses and distances as circumstances require, in order to pass, places of danger, at proper distances, which at all times ought to be duly noticed and regarded. It has too frequently happened, that ships working to windward in the British Channel, E. of Dunnofe, by making too long a board, have got upon the sand called the Ower; this sand is E. $\frac{3}{4}$ N. 25 miles from Dunnofe: But with 2 points variation W. the bearing is E.S.E. $\frac{3}{4}$ E. and W.N.W. $\frac{3}{4}$ W. which I hope will be duly regarded, for the preservation of yourself, the crew and cargo; for none feels the misery of shipwreck, but those who are so unhappy as to know it by experience.

H.	K.	$\frac{1}{2}$ K.	Courfes.	Winds.	Remarks on Thursday, 17th October, 1775.
7	5	I	SSW.	W.	Note. In the day time when we can fee land, we do not heave the log; but in the night we keep a log account, as in the adjacent columns.
8	5				
10	4		SbW $\frac{1}{2}$ W.		
12	4				
2	3	I	NW.	WSW.	At 4 P.M. Beachy bore N.E.bE. 3 or 4 leagues.
4	3	I	NWbN.	WbS.	At 6 P.M. ditto N.E.bE. 4 do.
6			NbW.	WbN.	Cloudy with a great fea, fet mizen TS. and jibb, reefed the TSails.
8			N $\frac{1}{2}$ E.	NWbW.	
10				WNW.	At 8 A.M. Beachyhead E.S.E. 4 or 5 leagues.
12					At noon, Beachy bore E.bS. Brighthelmstone N. $\frac{1}{2}$ W.

H.	K.	$\frac{1}{2}$ K.	Courfes.	Winds.	Remarks on Wednesday the 18th October, 1775.
7	4		S $\frac{1}{2}$ W.	WbS.	At 3 P.M. Beachy E.bN. $\frac{1}{2}$ N. 5 leagues. At 6 it bore E. $\frac{1}{2}$ S. At 8 in first reefs (TS.) topfail. At 10, stowed jibb, and mizen top-fail.
8	4	I			
10	5		SbE.		
12	4	I			
2	3		WbN $\frac{1}{2}$ N.	SW.	At 1 A.M. in second reefs, top-fails. At midnight we had strong gales and heavy squalls, with constant rain.
3	4		WNW.		
4	4		NW.	WSW.	At 8 A.M. Beachyhead E. $\frac{1}{2}$ S. 7 leagues. Out second reef main top-fail. At noon, Beachyhead W.bN. $\frac{1}{2}$ N. 7 leagues.
5	4	I	NNW.		
7	4	I	N.		
8					

H.	K.	$\frac{1}{2}$ K.	Courfes.	Winds.	Remarks on Thursday the 19th October, 1775.
2				NWbW.	Fresh gales, close reefed the top-fails, stowed the jibb and mizen top-fail. Beachyhead bore E.bS. 7 or 8 leagues.
4				WNW.	
7	3	I	NbE.		
8	2		WbS.	NW.	
9	2	I	WSW.		Dunnose bore N.W.bW. 5 or 6 leagues. Out 2d reefs TS's. Strong gales and Squalls. At noon, bore away for the Isle of Wight.
10	3				
12	2				
2	I	I			
4	I	I			
6			NNW.	W.	
8					
12				SWbS.	

Thursday the 19th, continued.

At half past 3 P.M. came to an anchor on the Mother-Bank in 5 fathoms water. Veered out about 70 fathoms of cable, in the night: Heavy gusts of wind and rain at midnight, veered away to a whole cable.

Friday the 20th of October, 1775.

At 4 A.M. the anchor started; let go the best bower anchor; lowered the yards down; got down main-top-gallant mast. At midnight hove up the best bower anchor, and hove in the second service of the small bower. Wind W.

Saturday the 21st of October, 1775.

Wind and rain; wind more gentle, at N.N.E.

Note. The short Service is about 60 fathoms; the long service is 1 cable: Or the half cable service, and the whole cable service. N.B. Jibb and gibb, denote the same; but some use one, and some the other.

Sunday

Sunday the 22d of October, 1775.

The forenoon cloudy, with rain; wind N.E.bE. At half past 10, hove up, and made fail, wind E.N.E. moderate breezes, and cloudy.

At 1 P.M. the Needle Point bore E. 2 miles.

At 2 P.M. Peveral Point 3 leagues. Wind N.E.

H.	K.	$\frac{1}{2}$ K.	Courses.	Winds.	Remarks on Monday the 23d of October, 1775.
2				N.	Fresh gales with rain. Handed main-top-gallant fail.
4					At 4 P.M. the Bill of Portland N.bW. 4 leagues.
6				NbW.	In first reefs, top-fails. At 6, Portland N.N.W. 4 or
8	4	1	WbN.		5 leagues. At 8 P.M. Portland Lights N.E. 6 or 7 leagues.
10	4	1			Fresh gales with a head swell.
12	5	1	W $\frac{1}{2}$ S.	NNW.	At 4 A.M. I took my departure from the Start, it bearing
2	4		W.		N.E.bN. 8 leagues, its lat. 50°.07' N. lon. 3°.47' W.
4	3	1			At 8 A.M. the Start bore N.E.bN. 7 leagues.
6	3		WbN.		
8	3	1			
10	3	1	W.		At noon we saw the land, bearing N.E.bN. 8 leagues.
12	3	1	WbS.		

H.	K.	$\frac{1}{2}$ K.	Courses.	Winds.	Remarks on Tuesday the 24th of October, 1775.
2	2	2	W $\frac{1}{2}$ S.	NWbN.	Moderate and cloudy.
4	2	2	WbS $\frac{1}{2}$ S.		
6	3	3	SWbW $\frac{1}{2}$ W.	NWbW.	Handed mizen top-gallant fail, in first reefs, fore and
8	3	3	SWbW.		mizen TS's.
10	3	3	NNE.	NW.	
12	2	2	NNE $\frac{1}{2}$ E.		
2	4	4	NEbN.	NWbN.	At 8 A.M. we saw the Lizard, N.bW. 8 leagues.
4	3	3			
6	2	2	W $\frac{1}{2}$ S.		
8	3	3	W.	NNW.	In first-reef main top-fail.
10	4	4	WbS.	NWbN.	Set main top-gallant fail.
12	4	4	WbS $\frac{1}{2}$ S.		Lat. obs. 49°35' N.
Made S. 54' W. 62'. X lat. 36' S. dep. 50' W. X lon. 65' W.					
Lat. in by acc. 49°.31'. M. dist. 50' W. lon. in 4°.52' W.					

Remark. That the departure found by the mid. latitude and the X longitude, between the Lizard and the ship, will be the same with the mer. distance made, provided no mistake has happened in the day's work: These must agree before you proceed further. Whence the bearing and distance of the Lizard may be found, by finding in the Traverse Table, the X latitude and departure, as in Plane Sailing. Also when the bearing and distance of the nearest land, &c. is required, work by mid. latitude and X longitude, to find the departure; and then, by X latitude and the departure, to find the bearing and distance. But when the places bear E. or W. from the ship, multiply the miles contained in 1° of that latitude, by the X of longitude, and the product will be the distance. [See Table, p. 60.] Or find the latitude of the parallel the ship is in, in degrees, and the longitude, in lat. col. (Trav. Table), and you will have the dist. in dist. column.

Remark. The bearing of the Lizard, the first day at noon, after the departure, is the opposite point to the course made good from it, which is N.E.bN. $\frac{1}{4}$ E. and the distance is that of the day 67 miles.

The 2d day. Lat. of the Lizard 49°.57' N.

Ship by obs. 48°.30' N.

X lat. 1.27 M. dist. 1°.06. These in miles are 87 and 66, which gives the bearing N. 37° E.—109 miles.

A LOG-

A LOG-BOOK and JOURNAL from the LIZARD towards the WEST INDIES, in the Thames Frigate, Capt. A. Blond, Commander; J. S. First Lieutenant, &c.

H.	K.	F.	Courses.	Winds.	Remarks on Sunday the 21st of January, 1776.
1					Variation 2 points W.
2					
3					
4				NEbE.	At 4 P.M. the Lizard bore N.E. dist. 10 leagues, that is, the ship bore from the Lizard S.W. by compass, dist. 30 miles; corrected is S.S.W.
5	2		WbS.	ENE.	The Land's-end bore N. $\frac{1}{2}$ E. 13 leagues, which corrected is N.bW. $\frac{1}{2}$ W.
6	1	6	6		All fails set.
7	2				
8	2	6	WbS $\frac{1}{2}$ W.		
9	2	6	14		
10	3				
11	3				Ushant, at noon, W. $\frac{3}{4}$ S. 47'.
12	2	6			Saw a sail S.W. which we gave chase to; it was a Portugueze
1	2	4	WSW $\frac{1}{2}$ W.		
2	2	4	20		
3	3				
4	2	4			
5	4				Drove to and fro' by the rowling of the sea.
6	2	4			
7	2	2			
8	1	2		calm.	
9					
10					
11					
12					

Dist per log 40'	made	Course	Dist.	S.	W.	M. lat.	lon. made	Sun's mer. alt. 21°.04'
Lizard add 30	good	S. 41° W.	67	50', 3	44', 3	49 $\frac{1}{2}$ °	1°.08 W.	Z.D. 68.56
Total 70								Decl. 19.56
								Lat. in by obs. 49.00 N.

A TABLE of the working (the Traverse) of each Day's Log-Book Account, from the Lizard, towards the West-Indies.

1st Day.	Courses correct.	Dist. miles.	N.	S.	E.	W.	
	SSW.	30	—	27,7	—	11,5	See p. 102, Notes 1 and 2.
	SWbW.	6	—	3,3	—	5,0	
	SWbW $\frac{1}{2}$ W.	14	—	6,6	—	12,3	
	SW $\frac{1}{2}$ W.	20	—	12,7	—	15,5	
	Made good SWbS $\frac{1}{2}$ W.	67		50,3		44,3	Mid. lat. 49 $\frac{1}{2}$ °, Gives lon. 68' W.
2d Day.	WSW.	4	—	1,5	—	3,7	
	SW.	7	—	5,0	—	5,0	
	S.	1	—	1,0	—		
	SWbS.	23	—	19,1	—	12,8	
	Made good SWbS $\frac{1}{2}$ W. Or S. 39° W.	34		26,6		21,5	Mid. lat. 49°. Gives lon. 33' W.
3d Day.	Made good SWbS $\frac{1}{4}$ W.	141	—	113,2	—	84,0	Mid. lat. 47° Lon. this day 123' W.

The

The second Day's Log.				Remarks on Monday the 22d of January, 1776.			
H.	K.	F.	Courfes.	Winds.			
1	1		W.	E.	Var. 2 points, W. Rain, and a little wind.		
2	1		4				
3	1	6					
4		6	WSW.	SE.	Mer. alt. observed L.L. $21^{\circ}.40'$ Add as in Table 3, p. 95, 21.09 True mer. alt. 21.49 Z.D. 68.11 S. Decl. 19.41 S. Lat. in 48.30 N.		
5		1	2 + 5				
6	1						
7		4			calm.		
8							
9							
10					JOURNAL. Lat. by acc. $48^{\circ}.33'$ N. Lat. by obs. 48.30 N. Mer. dist. 1.06 N. Lon. made 1.41 W. Lon. in 6.56 W. Lizard bears 37.00 E. Dist. 109 miles.		
11							
12	1		SSW.	NNE.			
1	1	2	SWbW.	NE.	Out all reefs. $48^{\circ}.30' - 6^{\circ}.56'$ ship. $48.53 - 4.55$.23 - 2.01 Uphant bears M. lat. 48.41 gives dep. $79^{\circ}.3$ E. } ENE $\frac{1}{2}$ E. 82 m.		
2	2		6 + 17				
3	2	2					
4	2	4	WSW.	ENE.	A large rowling sea from the E. which set the ship towards the S.W.		
5	2	4	5				
6	2	4	SWbW.	E.			
7	2		17				
8	1	4					
9	2	2					
10	2	6	A large	rowing			
11	3	1					
12	3						
Dist. per log 35 miles.				Lat. Y.D. $49^{\circ}.00'$ N.	Courie	Dist.	S.
				Made .27 S.	made.		W.
				Lat. in $48^{\circ}.33'$ N.	S. 39 W.	34'	26,6
							21,5
							49°
							33' W.

The METHOD of collecting the Particlars of the Journal, from the daily Account (of the Difference of Lat. Dep. and Lon. made) that Day.

Lat. of the place we took our dep. from.	Mer. Dist. made from the Lizard.	Lon. made from the Lizard.	Having obtained the lat. in, the dep. made from the merid. of the Lizard, and the lon. you are then to enter them in your Journal.
The Lizard in lat. $49^{\circ}.57'$ N.	dep. $0^{\circ}.44'$ W	lon. $1^{\circ}.08'$ W	Those particulars are to be obtained from the traverse of the day's work, which being worked on waste paper or on a slate, is then to be entered as are done at the foot of the first day's log. (See p. 112), where are wrought the trav. of the first three days.
We made - - - 0.50 S.			
21st. Lat. in by account 49.07 N.			
Lat. in Y.D. by obs. $49^{\circ}.00'$ N.	0.44 W	1.08 W	
Made this day - - - $.27$ S.	0.22 W	0.33 W	
22d. Lat. in by account $48^{\circ}.33$ N.	1.06 W	1.41 W	
Lat in Y.D. by obs. $48^{\circ}.30'$ N.	1.06 W	1.41 W	
Made this day - - - 1.53 S.	1.24 W	2.03 W	
23d. Lat. in by account 46.37 N.	2.30 W	3.44 W	
Lat. in Y.D. - - - $46^{\circ}.35'$ N.	2.30 W	3.44 W	
Made this day - - - 2.01 S.	$.45$ W	1.04 W	
24th. Lat. in by account 44.34 N.	3.15 W	4.48 W	

The third Day's Log-Book.				Remarks on Tuesday the 23d of January, 1776.							
H.	K.	F.	Courses.	Winds.							
1	3	6	SWbW.	SE.	Cloudy. Variation by azimuth $19^{\circ}.20' W.$						
2	4	6									
3	6	4									
4	6	2									
5	6	2		ESE.	In first reefs. Handed M.S.						
6	5	4									
7	5	6									
8	6	4									
9	7										
10	6	6									
11	6										
12	5	4									
1	5	4									
2	5	4									
3	5	4									
4	5	4									
5	5	6									
6	5	6									
7	6	6									
8	5	2									
9	6	3									
10	6	4									
11	6	4									
12	6	0									
Per log 141 miles.					JOURNAL. Lat. by obl. $46^{\circ}.35' N.$ Lat. by acc. $46^{\circ}.37' N.$ Mer. dist. - $2.30 W.$ Lon. made - $3.44 W.$ Lon. in - $8.59 W.$ Lizard bears N. $37.00 E.$ Dist. 252 miles.						
					Courfe.	Dist.	S.	W.	M. lat.	Lon. made	lat. in yd. $48^{\circ}.30' N.$ made $1.53 S.$ lat. in $46^{\circ}.37' N.$
					SWbS $\frac{1}{4}$ W.	141	113,2	84,0	47 $^{\circ}$	$2^{\circ}.03' W.$	

Fourth Day's Log.					Remarks on Wednesday the 24th of January, 1776.						
H.	K.	F.	Courses.	Winds.							
1	6	2	SW.	SEbE.							
2	5	6	40								
3	5										
4	5	2									
5	5	4									
6	5	4									
7	6	4									
8	5	6	SWbs.								
9	6		90	E.							
10	4	4									
11	5										
12	5										
1	5	6									
2	5	6			JOURNAL.						
3	5				Lat. by acc. 44°.34' N.						
4	6				Mer. dist. - 3.15 W.						
5	6				Lon. made 4.48 W.						
6		2			Lon. in - 10.03 W.						
7	6				Lizard bears N. 31.00 E.						
8	5	2			Dist. 380 miles.						
9	5	6			Var. by azimuth 17°.45' W.						
10	5	6			Ship 44°.34'—9°.40' W.						
11	5	6			C. Ortegale 43.52—7.30						
12	6	2			Diff. 00.42—2.17=137' } Dep. 98' C. Ortegale ESE.						
1	6				M. lat. 44°.13'— } X lat. 42 107 miles.						
2	5	2			Var. 1½ point W.						
3	5	6									
4	5	6									
5	5	6									
6	5	6									
7	5	6									
8	5	6									
9	5	6									
10	5	6									
11	5	6									
12	6	2	per log	129 m.	Courfe.	Dist.	S.	W.	M. lat.	Lon. made.	Lat. in y.d. 46°.35' N.
					S.20W.	130	121,4	45,0	45½	1°04' W	Made 2.01 S.
											Lat. in 44°.34' N.

Fifth Day's Log.					Remarks on Thursday the 25th of January, 1776.	
H.	K.	F.	Courses.	Winds.	Reet top-sails.	
1	8	3	SW. 53	ESE.	In first reefs.	
2	8	5				
3	9					
4	9	2				
5	9					
6	9					
7	8		SWbW. 138	SE.	JOURNAL. Lat. by acc. 42°.01' N. Lat. by obf. 42 .03 W. Mer. dist. 5 .07 W. Lon. made 7 .22 W. Lon. in - 12 .37 W. Lizard bears N. 33° E. Diff. 564 miles.	
8	8	6				
9	8	6				
10	8	3				
11	8					
12	8					
1	8			SEbE.	Out all reefs. Ship - 42°.03' N. 12°.48' W. C. Finistere 43 .03 — 9 .06 W. Diff. 1 .0 — 3 .42 M. lat. 42°$\frac{1}{2}$, and X lon. 222' gives dep. 163 E. Also the X lat. 60 and dep. 163 gives - - - Cape Finistere bearing - - - E.N.E. $\frac{1}{4}$ E. 174 miles. Variation 1$\frac{1}{2}$ W.	
2	7					
3	6	4				
4	7					
5	7					
6	7	3				
7	7	4				
8	7	4				
9	7	2				
10	7	2				
11	7	4				
12	8					
Per log 191 miles.					Courfe	Diff.
					S.	W.
					M. lat.	Lon. made
					lat. in Y.D.	44°.34' N. 4°.32' W.
					made -	2 .33 S. 2 .45 W.
					lat. in by acc.	42 .01 N. 7 .17 W.

Day.	Courses correct.	Diff. miles.	N.	S.	E.	W.	
4th Day.	SSW $\frac{1}{2} W.$	40	—	35,3	—	18,9	Mid. lat. 44° . Lon. made this day $1^{\circ}.04' W.$
	SbW $\frac{1}{2} W.$	90	—	86,1	—	26,1	
	SbW $\frac{3}{4} W.$ or, S. $20 W.$	131	—	121,4	—	45,0	
5th Day.	SSW $\frac{1}{2} W.$	53	—	46,7	—	23,0	Mid. lat. 44° . Lon. made this day $156' = 2^{\circ}.36' W.$
	SWbS $\frac{1}{2} W.$	138	—	106,7	—	87,5	
	SWbS $\frac{1}{4} W.$ Or S. $36^{\circ} W.$	190	—	153,4	—	112,5	
6th Day.	SSW $\frac{3}{4} W.$	235	—	201,6	—	120,8	Mid. lat. 42° , gives lon. made $1^{\circ}.03' W.$
7th Day.	SSW $\frac{1}{2} W.$	20	—	17,6	—	9,4	Mid. lat. $41^{\circ}.1$, gives lon. made $1^{\circ}.15' W.$
	SWbW $\frac{3}{4} W.$	16	—	6,8	—	14,5	
	SSW.	8	—	7,4	—	3,1	
	S $\frac{1}{4} W.$	3	—	3,0	—	0,1	
	S $\frac{1}{2} E.$	3	—	3,0	0,3	—	
	WNW $\frac{3}{4} W.$	23	5,6	—	—	22,3	
	SWbS Or S. $33^{\circ}.1 W.$	59	—	32,2	—	49,1	

Sixth Day's Log.				Remarks on Friday the 26th of January, 1776.			
H.	K.	F.	Courses.	Winds.	In 1st reefs.		
1	8	6	SW $\frac{1}{4}$ W.	ESE.	A strong gale but steady.		
2	9	7			The gale increases.		
3	9	7			In 2d reefs.		
4	9	6					
5	10						
6	10	1					
7	9	7					
8	9	6					
9	8	7					
10	8	3					
11	8	5					
12	8	4					
1	8	7					
2	8	5					
3	8	6					
4	9	1					
5	9	4					
6	9	7					
7	10						
8	10	3					
9	11	2					
10	11	7					
11	12						
12	12	1					

JOURNAL.
 Lat. by acc. $38^{\circ}.41' N.$
 Lat. by obs. $38^{\circ}.40' N.$
 Mer. diff. $7^{\circ}.08' W.$
 Lon. made $10^{\circ}.01' W.$
 Lon. in $- 15^{\circ}.16' W.$
 The Lizard bears $N. 32^{\circ} E.$
 Dist. $80\frac{1}{2}$ miles.
 Burlings E.bN. $- 300$ miles.
 Cape Roxent E. $- 281$ do.
 C. St. Vincent $S. 72^{\circ} E. 330$ do.

In $38^{\circ}.40'$ are $46,85$ miles in 1° , and $46,85$
 $\times 6$
 Dist. $281,10$

Ship	-	$38^{\circ}.40' - 15^{\circ}.16'$	X. lat.	X lon.	dep.
Burlings		$39^{\circ}.36' - 9^{\circ}.10'$	56	366	286
C. Roxent		$38^{\circ}.40' - 9^{\circ}.16'$	0	360	281
C. St. Vincent		$36^{\circ}.58' - 8^{\circ}.45'$	102	391	309

Variation $1\frac{1}{2}$ point W.

Per log 235 miles.	Course.	Dist.	S.	W.	M. lat.	Lon. made.
	SSW $\frac{1}{4}$ W.	235	201,6	120,8	$40^{\circ}\frac{1}{2}$	$2^{\circ}.39' W.$

8th Day.	Courses correct.	Dist. miles.	N.	S.	E.	W.	Remark, the 8th day. The 2d course is wrote as it was on the log board WNW $\frac{1}{4}$ N. which is NWbW $\frac{3}{4}$ W and must be taken out of the Traverse Table accordingly, or N. $5\frac{3}{4}$ points W. Also the 3d cou. NW $\frac{1}{4}$ N. which is NWbN $\frac{3}{4}$ W. or N. 3 points, and $\frac{3}{4}$ W. and so to be taken out from the Traverse Table.
	NWN $\frac{1}{2}$ W.	6	1,7	—	—	5,7	
	WNW $\frac{1}{4}$ N.	8	3,4	—	—	7,2	
	NW $\frac{1}{4}$ N.	3	2,2	—	—	2,0	
	SSE $\frac{1}{2}$ E.	2	—	1,8	0,9	—	
	S $\frac{1}{4}$ W.	1	—	1,0	—	—	
	Or NW $\frac{3}{4}$ W.	5	3,0	—	—	4,0	
	ESE $\frac{1}{4}$ E.	2	—	0,7	1,9	—	
	EbS $\frac{1}{4}$ E.	2	—	0,3	2,0	—	
	E $\frac{1}{2}$ N.	6	0,3	—	6,0	—	
	WSW $\frac{1}{4}$ W.	5	—	1,7	—	4,7	
	SWbW $\frac{1}{4}$ W.	5	—	2,6	—	4,3	
	WSW.	6	—	2,3	—	5,5	
	WSW $\frac{3}{4}$ W.	18	—	4,4	—	17,5	
	WbS $\frac{1}{2}$ W.	Dist. made.	10,5	14,8	10,8	50,9	
	Or S. 84° W.	41	—	10,6	—	10,8	
			—	4,2	—	40,1	

LOG-

LOG-BOOK and JOURNAL in the Thames Frigate, Capt. A. Bland, for Jamaica.

H.	K.	F.	Courses.	Winds.	L. Way.	Remarks on Saturday 27th January, 1776.
1	5		1. SW $\frac{1}{2}$ W.	NW.	$\frac{1}{2}$ point	Variation $1\frac{1}{2}$ point W.
2	5		20			
3	5					
4	5					
5	4	3	2. W $\frac{1}{2}$ S.	NNW.	$\frac{1}{4}$	Out all reefs.
6	4		16			
7	3	6				
8	3	4				
9	3	2	3. SW $\frac{1}{2}$ W.	NW.	1 point	Rain.
10	2	2	8			
11	1					
12	1					
1	1					Heavy showers.
2	1			WNW $\frac{1}{2}$ W.		
3	1	4	4. SSW.	WNW.	$1\frac{3}{4}$	
4	1	4	SbE. } SSE.	SWbW.	$0\frac{3}{4}$	
5	1	4	5. SEbS. } 3			
6	1	4	6. WNW $\frac{1}{2}$ W.	SWbS.	$1\frac{1}{4}$	
7	2	4	23			
8	2	6				
9	3					
10	5					A fine gale.
11	4	2				
12	4	3				

Per Log 73 miles.	Course.	Dist.	S.	W.	M. lat.	Lon. made.
	S. 57 W.	59	32,2	49,1	38,24	1° 03' W.

JOURNAL.	
Lat. by acc.	38° 08' N.
Mer. dist.	7 57 W.
Lon. made	11 04 W.
Lon. in	16 19 W.
Lizard bears N.	34 00 E.
Dist.	850 miles.

RULES for CORRECTING the DEAD RECKONING.

There are various circumstances which occasion the difference between the lat. by account, and that by observation; and sometimes it will happen that the difference may be 10, 15 or 20', in one day, and at other times such difference may be in two or three days: When this happens, and the latitude being correct by observation; for which, it is necessary to make a correction of the meridian dist. when your account is to be adapted to a plane chart; but for a reduced, or mercator's chart (as described in p. 85, 86, 87,) you must correct the lon. because in the plane chart you find the place of the ship, by the lat. and mer. dist. but in all mercator's and reduced charts you find the place of the ship, by the intersection of the meridian and the parallel of latitude passing through the longitude and latitude you are in; that is, where the lines of the latitude and the longitude the ship is in, meet, is the place of the ship.

The error of the Dead Reckoning † may arise from the course steered, sometimes by bad, or carelessly steering the course ordered, by too frequent yaws, especially in the night; or by the compass steered by, not traversing well; also the steering of the ship may be free from yaws, the time the log is hove, by which she will make more way than at a mean rate of sailing between the times of heaving the log; or the wind may happen to be a little stronger, or weaker, by which the officer of the watch would give her more or less way than she had made: These are particulars for which no correction can, with propriety, be made.

G g

* See

† By Dead Reckoning, is to be understood, the course, distance, X lat. and dep. made in one or more days, when applied to the account of the day wherein the lat. was observed.

* For the following, see page 119.

H. K.	F.	Courses.	Winds.	L. Way.	Remarks on Sunday the 28th of January, 1776.												
1	2	WNW $\frac{1}{4}$ W.	SWbS.	$1\frac{1}{4}$ point.	Var. $1\frac{1}{2}$ points W.												
2	4	4			Squalls.												
3	5	NWbW $\frac{1}{4}$ W.			Mer. alt. sun's L.L. obf. $61^{\circ} 15' S.$												
4	3				Add as in Tab. III, p. 95 11												
5	2	6	NW $\frac{3}{4}$ N.	WSW.	True alt. sun's center 61.26												
6	1	2	S $\frac{1}{2}$ W.	WbS.	Z.D. $28.34 S.$												
7	1	0			Decl $9.26 N.$												
8	0	6	SSW $\frac{3}{4}$ W.	WNW.	Lat. in by obf. $38.00 N.$												
9	ca	lm		drift	Lizard $49^{\circ} 57'$												
10				1 m. per h.	Ship 38.00												
11				NW $\frac{3}{4}$ N.	11.57												
12				is 5.	60												
1					X lat. 717												
2	1	SE $\frac{3}{4}$ S.	SW.	$1\frac{1}{2}$	Dep. 517												
3	1																
4	2	SEbE.	SbW.	$0\frac{3}{4}$													
5	3	ESE $\frac{1}{2}$ E.															
6	3	4															
7	5	WbS.		$\frac{3}{4}$													
8	5	SWbW.	SbE.	$1\frac{3}{4}$													
9	5	4	WSW.	S.	$1\frac{1}{2}$												
10	5	6	WbS.		$1\frac{1}{4}$												
11	6																
12	6																
Per log 70 miles.					<table><tr><th>Courfe.</th><th>Diff.</th><th>S.</th><th>W.</th><th>M. lat.</th><th>Lon. made.</th></tr><tr><td>S. 84° W.</td><td>$41'$</td><td>$4,2$</td><td>$40,1$</td><td>38°</td><td>$0.51'$</td></tr></table>	Courfe.	Diff.	S.	W.	M. lat.	Lon. made.	S. 84° W.	$41'$	$4,2$	$40,1$	38°	$0.51'$
Courfe.	Diff.	S.	W.	M. lat.	Lon. made.												
S. 84° W.	$41'$	$4,2$	$40,1$	38°	$0.51'$												

JOURNAL.

Lat. by acc. $38^{\circ} 04' N.$
 Lat. by obf. $38.00 N.$
 Mer. diff. $8.37 W.$
 Lon. made $11.55 W.$
 Lon. in $17.10 W.$
 Lizard bears $N. 36^{\circ} E.$
 Dist. 885 miles.

H.	K.	F.	Courses.	Winds.	Remarks on Monday the 29th of January, 1776.												
1	5	4	SWbS.	ENE.													
2	5		34.		Variation $1\frac{1}{2}$ point W.												
3	3	2															
4	6	2															
5	6	2															
6	5	4															
7	6	2	SSW.														
8	5	2	98.														
9	5	4															
10	5	2															
11	5	4															
12	5	2															
1	5	2		NE.													
2	4	6															
3	5																
4	5	2		NNE.													
5	6	2															
6	6	2															
7	6	2															
8	6	4															
9	5				In 3d reefs,												
10	4				Rain.												
11	5	2															
12	6	2		N.													
Per log 133 miles.					<table> <tr> <th>Courfe made.</th><th>Diff.</th><th>S.</th><th>W.</th><th>M. lat.</th><th>Lon. made.</th></tr> <tr> <td>S. $80\frac{1}{2}^{\circ}$ W.</td><td>$132'$</td><td>$130,0$</td><td>$19,6$</td><td>37°</td><td>$0.24' W.$</td></tr> </table>	Courfe made.	Diff.	S.	W.	M. lat.	Lon. made.	S. $80\frac{1}{2}^{\circ}$ W.	$132'$	$130,0$	$19,6$	37°	$0.24' W.$
Courfe made.	Diff.	S.	W.	M. lat.	Lon. made.												
S. $80\frac{1}{2}^{\circ}$ W.	$132'$	$130,0$	$19,6$	37°	$0.24' W.$												

JOURNAL.

Lat. by acc. $35^{\circ} 50' N.$
 Lat. by obf. $35.46 N.$
 Mer. diff. $8.57 W.$
 Lon. made $12.19 W.$
 Lon. in $17.34 W.$
 Lizard bears $N. 32^{\circ} E.$
 Dist. 1010 miles.

Remarks

Remarks on Tuesday the 30th of January, 1776.			
H.	K.	F.	Courses. Winds.
1	7	4	SWbS. N.
2	7	4	Variation $1\frac{1}{2}$ point W.
3	7	4	A fine gale, but foggy.
4	7	6	At 4 P.M. took leave of the Commodore; convoy to the West India Fleet, about 250 sail.
5	7	6	In 2d reef.
6	7	6	Lightened towards S.E.
7	8	4	
8	7	5	Saw a sail towards the East.
9	7	4	Down chests and up hammocks; cleared the gun deck, and made ready for fighting.
10	7	4	Saw a sail to the S.E.
11	6	6	
12	6	4	
1	6		
2	5	2	
3	4	4	Up chests and down hammocks.
4	5		Out all reefs.
5	5	4	
6	5		
7	6		
8	6	2	
9	6	4	
10	7		
11	7		
12	6	2	

Lat. by acc.	33°.14' N.
Lat. by obs.	33.12 N.
Mer. dist. -	9.43 W.
Lon. made	13.15 W.
Lon. in -	18.30 W.
Lizard bears N. 30° E.	
Dist. 1160 miles.	
At noon, Madeira S.bW. 12 leagues.	
Lizard 49°.57'	
Ship 33.12	
16.45 = 1005	
M. dist. 9.43 = 583	

Per log 159 miles.	Courfe made.	Diff.	S.	W.	M. lat.	Lon. made.	Ship - 33°.12'—18°.30' W.
	SbW $\frac{1}{2}$ W.	159	152,2	46,1	34 $\frac{1}{2}$	0°56'W.	Madeira 32.30—17.28 W.
							Diff. .42—1.02
							Bears S. 51° E. Dist. 67 miles.

Remarks on Wednesday the 31st of January, 1776.

At 2 P.M. we made the Madeira; and at 5 P.M. came to anchor in the road of Funchall. So ends this Journal.

N. B. That 5 P.M. noted under the 31st, is absolutely the 30th at 5 P.M. for reasons given in p. 106, for all afternoon hours, belong to the foregoing day.

See Art. 7, p. 103. Note that the error of lat. by the course and dist. seldom differs more than 3 or 4': but the error in the lat. arising from other causes, may be 20 or 30', or more, in one day, and this generally happens when in a tide's way, or where a current so acts upon the ship as to increase or retard her motion through the water, so that the difference of the distance given by the log and glass (and that made by the ship) may be 3 or 4' an hour, as in sailing along coasts, and in gulfs and straits. Ships coming from India towards the Cape of Good Hope are frequently set from 30 to 60 miles in a day, a-head of their reckonings.

By high seas and sudden squalls, the way a ship makes, or the course, is impossible to be determined; and therefore, to correct the meridian dist. or the longitude made in such days, is also impossible.

Having said what is necessary of the fore-mentioned particulars, where correction cannot be made, I now propose to shew wherein it may be made, when the lat. by account, and that by observation, differ.

When you have made all proper allowances of variation and lee-way, and obtained, the set and drift of currents, (if any) and these taken into account; and after all find your lat. by account, and by observation, disagree; then before you can think in the least how to make a

* correc-

* For the following see p. 121.

THE following is a regular Journal from Teneriff, one of the Canary Islands (the peak of which may be seen 100 miles distance at sea): Its lat. $28^{\circ}.25' N.$ and $16^{\circ}.25' W.$ lon. This Journal falls in with that which I kept on board the Prince Henry Indiaman, from the Lizard to St. Helena in $16^{\circ} S.$ lat. and $5^{\circ}.54' W.$ lon. I have adapted the same months and days of the Month, to the year 1776, and all the other circumstances that happened after the 3d Day of February, where this coincides with mine, both in lat. and longitude; together with the remarks made on said voyage, in the year 1761.

February 1st, at 9 A.M. we took our departure from Teneriff, bearing E.S.E. dist. 21 leagues. And at noon, we were in lat. $28^{\circ}.39' N.$ and $1^{\circ}.54' W.$ lon. from the Peak.

	X lat.	Dep.	Lon. made each day.	Lat. by acc.	Lat. by obs.	Lon. in.	Bearing and distance to the nearest Land.
Feb.							At noon, Peak of Teneriffe E.S.E. dist. 33 leagues. Var. $1\frac{1}{2}$ point W.
1			$0^{\circ}.154$	$28.39N$	$28.30N.$ g.	$18.19W$	
2	62S	152W	2.56W	27.28	27.30N. g.	21.15	
3	67	158	3.10	26.21	26.23N.	24.25	
4	73	35	1.21	25.08	25.09N. g.	25.46	
5	8	32	0.36	25.00	25.02N.	26.22	
6	28	36	0.40	24.32	24.35	27.02	
7	53	43	0.44	23.39	23.42	27.46	
8	79	27	0.30	22.20	22.23	28.16	Var. by az. $6.48W$
9	152	25W	0.27W	19.48	19.46	28.43	Do. 6.07
10	179	14E	0.15E	16.49	16.52	28.28	Do. 5.57
11	165	47	0.49	14.04	14.10	27.39	Do. 4.51
12	138	57	0.58	11.46	11.50	26.41	Do. 5.40
13	154	64	1.01	9.12	9.24N. g.	23.40	Do. 4.10
correct	- 12	+ 5					
14	131S	64E	1.05E	7.13N	7.10N.	24.35W	
15	120	58	0.59E	5.13	5.08N.	23.36	Do. 5.00W
16	108	33	1.33E	3.25	3.25N.	22.03	Do. 5.43
17	19	3E	0.57W	3.06	Cloudy.	23. 0	
18	29	0	0.00	2.37	2.17 bad	23. 0	
19	30	28W	2.53W	1.42N	1.42N g.	23.53	Do. 5.00
	+ 25	+ 26					
20	41	21	1.37E	1.01S	1.01S g.	24.16	Do. 5.01
21	61	43	0.43W	0. 0	0.00 g.	24.59	Do. 4.15
22	22	32W	0.32W	0.22	0.22 g.	25.31	Do. 3.30
23	54	11E	0.11E	1.16	1.16 g.	25.20	Do. 3.20
24	40	16	0.16W	1.56	1.56 g.	25.36	Do. 3. 0
25	91	14	0.14	3.27	Cloudy.	25.50	Do. 2.30
26	88	21	0.21	4.55	Do.	26.11	Do. 1.43
27	127	33	0.33	7.02	7.02S. g.	26.44	Do. 1.20
28	123	59	1. 0	9.05	9.07 g.	27.44	Do. 0.40
March 1	121S	53W	0.54W	11.06S	11.10 g.	28.38W	Do. 0.15E
2	137	49	0.53	13.23	13.28S.	29.31	Do. 1.10
3	128	13	0.16	15.31	15.31 g.	29.47	Do. 1.45
4	95	19W	0.19W	17.06	17.10 g.	30.06	Do. 2.10
5	112	5E	0.05E	18.58	19.05 g.	30.01	Do. 2.36
6	88	7	0.08	20.26	20.32 g.	29.53	Do. 2.50
7	92	36					
	+ 14	+ 4	0.42	22.12	22.12 g.	29.11	Do. 3. 0
8	52	47					
correct	+ 7	- 9W	0.41	23.11	23.11 g.	28.30	Do. 2.40

X Lat.

Note. g. stands for good; that is a good observation.

	X lat.	Dep.	Lon. made each day.	Lat. by acc.	Lat. by obf.	Lon. in.	Bearing, distance and variation in 1761.
March							
9	60S	45E	0.50E	24.11S	24.11S. g.	27.40W	Var. by az. 3.00E
10	100S	76E	1.23	25.51	25.51 mid.	26.17	Do. 2.50
11	74S	49E	0.56	27.05	27.05 g.	25.21	Do. 1.30
12	80S	33E	0.37	28.25	28.25 g.	24.44	Do. 1.35
13	85S	49E	0.56	29.50	29.50 g.	23.48	
14	10S	19E	0.21E	30.00	30.00 g.	23.27	Do. 2.50
15	10S	5W	0.06W	30.10	30.10 g.	23.33	Do. 3.30
16	21S	118E	2.16E	30.31	30.30 g.	21.17	Do. 2.30
17	10S	35E	0.42	30.40	30.41 g.	20.35	Do. 0.20
18	20S	10E	0.11	31.00	31.00 g.	20.24	Do. 1.30
19	38S	86E	1.39	31.38	31.38 g.	18.45	Do. 1.35E
20	30S	92E	1.47	32.08	32.08 g.	17.46	Do. 0.30W
21	16S	139E	2.44	32.24	cloudy	14.14	Tristian de Cunha
22	5S	168E	3.20	32.29	32.30 mid.	10.54	S. 9° E. 290 miles.
23	29N	120E	2.22	32.00	cloudy	18.32	Var. by az. 3.30
24	22N	30E	0.34	31.38	31.38 g.	7.58	
25	10N	36E	0.43	31.28	31.28 g.	7.15	Do. 5.25
26	33N	89E	1.44	30.55	30.54 g.	5.31	Do. 6.10
27	95N	77E	1.28	29.20	29.20 g.	4.03	Do. 7.00
28	69S	32E	0.37	30.29	30.29 g.	3.26	Do. 8.20
29	4S	42E	0.48	30.33	30.34 g.	2.38	Do. 9.00
30	113N	91E	1.45	28.40	28.40 g.	0.53W	Do. 10.10
31	169N	86E	1.37	25.51	25.59 g.	0.44E	Do. 10.30
April 1	183N	46E	0.50	22.48	22.56 mid.	1.34	Do. 11.30
2	169N	32E	0.35	20.01	20.05 g.	2.09	Do. 11.50
3	154N	27E	0.28E	17.27	17.31 g.	2.37	Do. 12.40
4	68N	25W	0.26W	16.19	16.23 g.	2.11	Do. 12.40
5	6S	65W	1.08	16.25	16.25 g.	1.03	Do. 11.40
6	29N	36W	0.38	15.56	15.56 g.	0.25	

In the bay, off Sugar-loaf Point, where we came to anchor in 10 fathoms water before Union Castle, St. Helena, April 6th at 7 A.M. 1761.

The longitude of Union-Castle is 5°.54' W. from the meridian of London.

The longitude of do. by account 0.25 E.

Error in lon. by our account, was 6.19 E. (that the account was E.) of the place we were in.

* correction to the particulars you before corrected, according to the best of your judgment, you must measure the log-line, and try the glass by which the line was reckoned; and after trial, suppose both the glass and the line to have lengthened, which is frequently the case in damp and rainy weather, with high winds and rough seas, so that the glass may run near 1 or 2" longer than it should, and the line may be stretched in due proportion, to the running of the glass; when this is the case, no correction can be made of distance.

Suppose the glass runs 28", and the line adapted to it be 42 feet; that is 4" to 6 feet, 2" to 3 feet, and 1" to 1½ foot; so that if the glass runs 29" and the distance between the knots being increased to 43½ feet, such glass and line will give the true distance agreeable to the 28" to 42 feet; and so of any other glass and line, being lengthened in such proportion: But if they are not found to be so, correct by the proportion as mentioned in p. 105. I apprehend the course a ship makes good in a day may be determined to ¼ of a point, and that the true distance may be found within the limits of 6 miles; now taking 6 to be the extreme error (when currents have not acted): And if the course be N. or S. or if it be 2, 3, 4, &c. points from the meridian, or from E. or W. then ¼ point error in the course, and 6 in the distance, will alter the latitude as per table following.

H h

If

If the error of the distance gives 6 miles.			
When the course is 1 point.	X lat.	Dep.	If the error of latitude by account does not differ more than as per column, do not correct the mer. dist. or longitude.
2	5,9	1,2	
3	5,5	2,3	
4	5,0	3,3	
5	4,2	4,2	
6	3,3	5,0	
7	2,3	5,5	
8	1,2	5,9	

RULES for correcting the DAILY ACCOUNT: A very precarious thing.

1. When your course, or courses made good, for one or more days, does not exceed 2 points from the meridian, and the difference of latitude by account and by observation does not exceed 6 or 8', you may omit correcting; but if it be 10' or more, then examine to find the real cause, or what is the most likely to have produced it, and correct accordingly.

2. If you be near a coast, the flood and ebb tides will run nearly parallel to that coast; and when it so happens, you are to find by your tide table the times of high water at different places along the coast, by which you will find the way that the flood tide runs, as also, that of the ebb; you are then to find the time of high water that day on the coast; and by that and the set, you may find if it could be the cause of the difference of the latitude; and if so, correct accordingly.

3. If you cannot find any cause of the difference of the latitudes, then pass it; as you had better omit correction, than to correct without reason. For it is certain, that neither the course nor the distance can be justly obtained. There may happen in heaving the log 24 times, to be 24 quarters, or 6 miles, error, sometimes less and sometimes more; and at other times, the errors in distance may nearly correct each other; and the course or courses corrected, may be nearly true.

Note. That corrections of reckonings in mer. dist. and lon. should seldom be attempted; except by celestial observations.

4. If the course made good be between 2 and 6 points, and if the Diff. of the latitudes be 4 or 5'; and being out of tide's way, which suppose to be 10° from any coast; then correct the distance and mer. distance by the diff. of the latitudes and the course, by which you will find the increase or decrease of dist. and dep. which being done, find the longitude.

When you make a correction of mer. distance; find the longitude made, by the mid. lat. and mer. dist. as directed in p. 102.

5. If a ship makes her way good (by account) due E. or W. in any given lat. and if the error in lat. be 12'; this error cannot be produced by $\frac{1}{4}$ point error of the course, or by the distance, therefore the effect must have been produced by some other cause, which you must search out, and correct accordingly. When the diff. of latitude happens to exceed those that are in the column under lat. in the little Table foregoing, you may be sure that a current has in a great measure occasioned it (if the log-line and glass be true): In this case, when the direction of the current cannot be found, no correction ought to be made; but if you can nearly assign the set of the current, you may correct accordingly.

6. When the variation is well determined by observation, the courses may be truly corrected; and the course made good from day to day, may in general be allowed not to err more than $\frac{1}{4}$ of a point; and the error in dist. where care is taken, can seldom exceed 6 miles; so by trial, if these do not make the lat. by account and that by observation agree, you may attribute something else to be the cause, which try to find by the foregoing, and correct accordingly.

REMARKS

REMARKS on the JOURNAL to MADEIRA.

By the direction of the coasts of France, Spain and Portugal, I apprehend the tide flows N.N.E. and ebbs S.S.W. and makes high water on the full and change days, at different parts, from 12 to 3 P.M. the drift between 2 and 3 minutes an hour.

The first day after our departure from the Lizard, the lat. by observation being 7' S. of that by account, by which we may with reason attribute the set of the ebb tide had drove the ship nearly S.S.W. so as to occasion the difference 7' S. I therefore correct as under.

	Dist.	S.	W.	
Made by account	67	50,3	44,3	Whence the Lizard bears N. 40° E. dist. 74 miles; and we have 1°.12' W. lon. from the Lizard; for 2,7 dep. under 49°, gives 4' longitude.
Correct S.S.W.	7	6,5	2,7	
Made good S. 40° W.	74	56,8	47,0	

The second day (after our departure) the difference between the latitude by account, and that by observation, was 3' S. which we may attribute to the same cause as of the foregoing day, but shall not correct for so small a difference; as the like differences 3, 4, or 5' per day, may happen for several days together; and when the tide acts contrary ways on the ship, the contrary effect will happen; which is a common case.

The third day, we were 2' S. of account; the fifth day, we were 2' N. of account; the sixth day, 1' S. the eighth day, 4' S. the ninth day, 4' S. the tenth day, 2' S.

At 2 P.M. made the Madeira, where we found our reckoning was 10' W. of the ship: Now if we correct the account for the excess of Southings, which is 14' S. by supposing the error to be in the distance that the ship got a-head of the reckoning, whether by the log-line being too long for the half-minute glass, or by the officer's of the ship giving her too little way on the log-board; from either of these, we must take a course, about a mean of the courses made these nine days past; suppose S.W.b.S. this will give 9,4 Westing; by this and 40°, the mid. lat. we got 12' W. longitude, which makes our reckoning worse; but this was not the case, for we were 12' in lon. W. of what the ship was in, therefore both the foregoing probabilities of the error in lat. were wrong; and as our compasses were pretty good, when compared with the azimuth compass with which we made our observations, to obtain the variation: This being the case, no correction can be made for an error in the course; we must, in consequence thereof, attribute the error to have been occasioned by the tides, and that they had set the ship towards the East; we may, therefore, with reason suppose, both by this Journal, and many others, that the force or drift of the tides (when sailing within 6, 8 or 10° of the coast) set ships towards the East, and the nearer you sail to the coast, the greater will the drift be; which ought to be regarded.

REMARKS on the JOURNAL from TENERIFF to ST. HELENA.

The 1st February, at noon, the lat. by account, and that by observation, agreed; and after three days sailing, the latitudes only differed 1'; from thence to the 12th, they only differed 4'; but on the 13th, the difference was 12' N. of account; and with good reason; for by viewing the chart of the coasts of Africa and America, it is evident that the principal effect of the tides will be nearly W.N.W. this course and 12' diff. of lat. will give 29,5 dep. W. and this dep. and mid. lat. 10° will give an increase of longitude 30' W.

19th, The most part of the last 24 hours, we had a considerable swell from the S.E. therefore have made the correction as in the table.

March 7th, 1761, By our account, the ship passed the I. Trinidad, which isle we expected to see, but were disappointed; and by our longitude observations we passed 4 or 5° W. of it. Notwithstanding which, by our variation being 3° E. we must have passed W. of it about 6°; and being only about 10° from the coast of Brazil, we may suppose to have had the tide acting on the ship nearly N.N.W. and S.S.E. and that day it was high water on that coast about 5 h. in the morning. See the following.

1. Remark,

1. Remark, Off C. St. Augustine, high water on full and change days at 4 h. 30 m. to which add the time the moon passed the meridian - - - - - 0 48

High water - 5 18 therefore,

we had the whole of the ebb, by which the ship was drove so as to increase her difference of latitude by account 14' S. and taking the set to be S.bE.½E. we have 4' dep. E. as per table.

March 8th, Our lat. by account was increased 7' S. and suppose the effect of the current to have been as much E. as W. *, so that the dep. may be taken for true. The next correction is on the 1st of April, when the latitudes differ 8', having made that quantity towards the N. more by account than by observation; we shall make no correction of mer. dist. or lon. for it, but see the result of some following days, whereby they agreed.

2. Remark, On the 12th of March, we had a rowling sea from the S.E. which retarded the way of the ship; that day we differed our lat. by account 95' S. and by observation only 80'; I therefore took the difference of the latitudes 15, and the set of the sea N.W. for a course, by which I found the decrease of distance and the departure, and then, the difference of longitude, as inserted in the columns. The 13th, the diff. lat. by account was 75, and by observation 85' S. The 17th, diff. of lat. by account 4' S. by observation 10' S.

The 18th, ditto - 13 S. ditto 20 S.

The 20th, ditto - 24 S. ditto 30 S.

The 29th, ditto - 8 N. ditto 5 S.

This day we sailed 8 different courses, and with 10 different winds; the courses were between the S.E. and N.E.bN. and the dist. by the log was 58 miles: This difference we attributed to be occasioned by a rowling sea from the N.E. which set us S.W.

March 31st, We made 6' more by account than by observation; and 3' the following day. The 2d of April, 4' less than by observation: All these may be allowed to be errors of the daily account, as defined in page 117 and 122, Rule II.

3. Remark, By the Principles of tides, and the form of the coasts of Africa and America, it is evident, the tide constantly runs towards the W.N.W. and that it may differ the latitude of a ship sailing between 20° N. and 30° W. to 30° S. about 3 or 4' each day, and the lon. from 6 to 8 or 10' a day. Now let us take 7' per day, from the 9th of February to the 6th of April, which is 55 days, and 55 times 7 is 385' = 6°.25', the increase of longitude W. this agrees with what we were deficient in; and I am of opinion, it is a general effect of tides, and is what should always be taken into account. I humbly submit this opinion to the experienced in these parts of the Atlantic.

Commodore ANSON's VOYAGE in the CENTURION.

In the lat. 10° S. and 36°½ W. had sounding 60 fathoms; and the Tryal a-head of us, had at one time 37, which increased to 90 fathoms; and a little after, no soundings with 150 fathom line upon the edge of it. This shoal is called Abrollos. We were then between 60 and 90 leagues from the coast of Brazil.

After we had passed 16° S. lat. we found a considerable current setting to the Southward this happens all along the coast of Brazil, and to the Southward of the river Plate. And as the reverend Mr. Walter, chaplain of the Centurion, says, that it is natural to suppose its general course is determined by the bearings of the adjacent shore. Perhaps too, in almost every other instance of currents, the same may be true, as I believe no examples occur of considerable currents being observed at any great distance from land. If this then could be laid down for a general principle, it would be always easy to correct the reckoning by the observed latitude. It is much to be wished, for the general good of navigation, that the actual settings of the different currents which are known to take place in various parts of the world, were examined more frequently and accurately than hitherto they appear to have been. The high land of the Brazils appeared at 17 leagues distance near the I. of St. Catharines; the flood tide set from the S.S.E. and the ebb N.N.W. that is, the flood runs N.N.W. and the ebb S.S.E. about 2 miles an hour.

Of

* Occasioned by the ebb and flood of the tide.

OF GREAT CIRCLE SAILING.

GREAT CIRCLE SAILING is the art of failing in or near the arch of the great circle which passes through the two places.

This kind of failing is only useful when the difference of the longitudes of the places are very considerable, suppose 40, 50, 60 or more degrees; of which we shall give some examples by way of illustration.

I do not here lay down the principles of spherical trigonometry, nor the construction of figures, but refer the reader to my Supplement, where he will find concisely demonstrated, and evidently clear, the principles of spherics, and the practical application, plain to any one who understands the foregoing elements.

PROBLEM I.

Suppose one place at the equator, and the other in 50° N. and their diff. of longitude 60° E. from that at the equator, to find the bearing of each from the other, and their distance.

General Proportion. As R : cs, lat. :: cs, X lon. : cs, of the dist.

To find the bearing of the place in the N. latitude, from that at the line; also the bearing of that at the line.

$$\begin{array}{l} \text{As R : ct. X lon. } 60^{\circ} = 10,2385606 \\ \text{: s, of the lat. } 50 = 9,8842540 \\ \text{: ct. bearing } 37 = 10,1228146 \end{array}$$

$$\begin{array}{l} \text{And R : ct. lat. } 50^{\circ} = 9,923814 \\ \text{: s, X lon. } 60 = 9,937531 \\ \text{: t. bearing } 36 = 9,861345 \end{array}$$

$$\begin{array}{l} \text{Thus R : cs, } 50^{\circ}.00' = 9,808067 \\ \text{: cs, } 60.00 = 9,698970 \\ \text{: cs, of dist. } 71.15 = 9,507037 \end{array}$$

Which is 4275 dist. in the arc of the g. circle.

And 4320 by mercator's method.

Mercator's 45 miles more than the g. circle.

Hence the place at the line whose lon. is 60° W. from the Lizard, bears S. 27° W.

And the bearing of the place in 50° N. from the place at the equator, is N. 38° E. dist. 4275'.

PROBLEM II.

The lat. of two places in the same parallel, and their diff. of longitude given; to find their nearest dist. or that in the arch of a great circle, the angle of position; and the greatest lat. of the arc (in passing) from one of the given places to the other.

General Canons. 1. R : ct. of the lat. of the parallel :: cs, of $\frac{1}{2}$ the diff. of longitude : ct. of the greatest latitude.

2. R : cs, lat. :: s, $\frac{1}{2}$ the diff. lon. : s, of $\frac{1}{2}$ the distance.

3. R : t. $\frac{1}{2}$ X lon. :: s, lat. : ct. of the bearing from the pole of the same name as the latitude.

Ex. Let the Start in lat. $50^{\circ}.09'$ N. lon. $3^{\circ}.28'$ W. be one of the places; and a part of St. John's, in America, 50.09 N. lon. 52.18 W. be the other place.

Diff. of lon. 48.50 W. from the Start.

Half 24.25

$$\begin{array}{l} 1. \text{ R : ct, lat. } 50^{\circ}.09' = 9,921503 \\ \text{: cs, } \frac{1}{2} \text{ lon. } 24.25 = 9,959310 \\ \text{: ct, greatest lat. } 52.46 = 9,880813 \end{array}$$

$$\begin{array}{l} 2. \text{ R : cs, lat. } 50^{\circ}.09' = 9,806709 \\ \text{: s, } \frac{1}{2} \text{ lon. } 24.25 = 9,616338 \\ \text{: s, } \frac{1}{2} \text{ dist. } 15.21\frac{1}{2} = 9,423047 \end{array}$$

Its double is the dist. $30.43 = 1843$ m.

$$\begin{array}{l} 3. \text{ R : t. } \frac{1}{2} \text{ X lon. } 24^{\circ}.25' = 9,657028 \\ \text{: s, lat. } 50.09 = 9,885205 \\ \text{: ct. bearing N. } 70^{\circ}.47' \text{ W.} = 9,542233 \end{array}$$

Note the distance in a parallel of latitude, is 1883 miles, which is 40 miles more than in the great circle.

I i

P R O.

P R O B L E M III.

The latitudes and longitudes of two places in the same hemisphere, being given; to find their distance and bearings in respect of each other.

G E N E R A L R U L E S.

Take the complements of the latitudes, and find half the sum and half the difference; also take half the difference of their longitudes. Then it will be:

1. As the s , of $\frac{1}{2}$ the sum : s , of $\frac{1}{2}$ the diff. :: $ct.$ of $\frac{1}{2}$ the diff. of lon. : $t.$ of $\frac{1}{2}$ the diff. of the bearings.

2. As cs , $\frac{1}{2}$ the sum : cs , $\frac{1}{2}$ the diff. :: $ct.$ $\frac{1}{2}$ the diff. of lon. : $t.$ $\frac{1}{2}$ the sum of the bearings. The half diff. of the bearings, added to the half sum of them, will be the bearing of that place, which is in the lesser latitude, from that of the greater latitude; and the half diff. taken from the half sum will be the bearing of the place, which is in the greater latitude, from that of the place in the lesser latitude. Note these bearings are angles.

To find the DISTANCE.

3. As the s , of the bearing of the lesser $\angle$: cs , of the lesser lat. :: the s , of the diff. of lon. : s , of the distance.

P R O B L E M IV.

The lat. of one place in $50^\circ N.$ the other in $55^\circ N.$ and their diff. of longitude $73^\circ.42' W.$ from the place which is $50^\circ N.$

Lizard $50^\circ N.$ compt. 40°

Cape Jones $55^\circ N.$ compt. 35

Suppose the Lizard $3' N.$ of its Cape.

X of lon. $73^\circ.42' = \angle$ at the pole.

Half do. $36.51 = \frac{1}{2}$ the contained $\angle$.

Sum	75		
Diff.	5	co-ar.	
Half Sum	$37.30'$ its s ,	$0,215553$	As cs , $37^\circ.30' - 0,100533$
Half diff.	2.30 its s ,	$8,639680$	: cs , $2.30 - 9,999586$
Half contained $\angle$	36.51 its $ct.$	$10,125253$	:: $ct.$ $36.51 - 10,125253$
: $t.$ $\frac{1}{2}$ diff. of bearings	$5^\circ.28 =$	$8,980486$	: $t.$ $\frac{1}{2}$ sum $59.14\frac{1}{2} - 10,225372$
			+ $\frac{1}{2}$ diff. 5.28

The bearing of the Lizard from C. Jones is $N. 64^\circ.42\frac{1}{2}' E.$ } or angles of
The bearing of C. Jones from the Lizard is $N. 53^\circ.46\frac{1}{2}' W.$ } position.

To find their DISTANCE.

As s , of the lesser $\angle$	$53^\circ.46\frac{1}{2}' - 0,09328$	As s , of the greater bearing	$64^\circ.42' - 0,04373$
: cs , greater lat.	$55.00 - 9,75859$	: cs , lesser lat.	$50.00 - 9,80807$
:: s , X lon.	$73.42 - 9,98218$	:: s , X lon.	$73.42 - 9,98218$
: s , of the dist.	$43.02 - 9,83405$	: s , of the dist.	$43.01 - 9,83398$

Dist. in miles $2582 = 43^\circ.02$ the whole arc.

By Mercator $N. 8^\circ W.$ $2698 - 26.22$ from the Lizard to the place of greatest lat.

The difference of dist. 116 $16.40 = 1000$ miles, the arc of dist. between the place of the greatest lat. and C. Jones.
between the arc of a great circle and mercator's

P R O B L E M V.

The latitudes of two places, and their diff. of lon. being given; to find the bearings and distance in the arch of a great circle; also the courses and distances to be sailed, so as to differ the lon. 10° in each arch.

Suppose a ship is to sail from the Lizard to Cape Jones on the coast of Hudson's Bay, in lat. $55^\circ N.$ and $73^\circ.42' W.$ (from the Lizard); What course must she sail at each 10° of lon. from the Lizard.

By

By the solution to Prob. IVth, the course to sail from the Lizard is N. $53^{\circ}.47'$ W. but as the angles of the position of the arch, with the meridians will continually increase*; and as the steering of a ship to a certain quantity, less than the quarter of a point of the compass, is impractical, I shall therefore shew the practical method, which is as follows.

First, calculate the difference of longitude of the place where the arc of distance passes the nearest to the pole (or passes the greatest lat.) then find the bearings at each 10° of lon. from the Lizard: And remark, that the course to be sailed from one place to the other, at each 10° of lon. will be the nearest point and quarter to the mean of the two bearings, at the extremes of the arc or distance to be sailed.

Note. The bearings and distance are found in Prob. IV.

To find the greatest lat. of the arch.

$$\begin{array}{l} \text{Ge. Can. As R : cs, lat. } 50^{\circ}.00' - 9,808067 \\ \quad :: \text{cs, bearing } 53^{\circ}.46' = 9,906683 \\ \quad : \text{cs, greatest lat. } 58^{\circ}.46' = 9,714750 \end{array}$$

To find the dist. between the Lizard and the place of the greatest latitude.

$$\begin{array}{l} \text{As R : ct. lat. } 50^{\circ}.00' - 9,923813 \\ \quad :: \text{cs, bearing } 53^{\circ}.47' = 9,771556 \\ \quad : \text{t. dist. } 26^{\circ}.22' = 9,695369 \end{array}$$

From the Lizard to the place of the highest lat.

To find the diff. of lon. between the meridian of the Lizard, and that which passes through the arch in the highest latitude.

$$\begin{array}{l} \text{As R : t. of bearing } 53^{\circ}.47' - 10,135289 \\ \quad :: \text{s, lat. Lizard } 50^{\circ}.00' - 9,884254 \\ \quad : \text{ct. X lon. } 43^{\circ}.43' - 10,019543 \end{array}$$

Whole X lon. $73^{\circ}.42'$

X lon. betw. the place
of gr. lat. and C. Jones } $29^{\circ}.59'$

To find the dist. of the first 10° of longitude of the arch.

$$\begin{array}{l} 1. \text{ R : t. X lon. } 33^{\circ}.43' - 9,824346 \\ \quad :: \text{cs, greatest lat. } 58^{\circ}.46' - 9,714750 \\ \quad : \text{t. of the dist. } 19^{\circ}.05' = 9,539096 \end{array}$$

Lizard to grt. lat. $26^{\circ}.22'$ in the arc of dist.
Arc of dist. $7^{\circ}.17' = 437^{\frac{1}{2}}$ miles.

$$\begin{array}{l} 2. \text{ R : t. greatest lat. } 58^{\circ}.46' - 10,217229 \\ \quad :: \text{s, arc dist. } 19^{\circ}.05' - 9,514472 \\ \quad : \text{ct. bearing } 61^{\circ}.40' - 9,731701 \end{array}$$

$$\begin{array}{l} 3. \text{ R : t. X lon. } 23^{\circ}.43' - 9,642777 \\ \quad :: \text{cs, greatest lat. } 58^{\circ}.46' - 9,714750 \\ \quad : \text{t. dist. } 12^{\circ}.50' - 9,357527 \end{array}$$

$$\begin{array}{l} 4. \text{ R : t. greatest lat. } 58^{\circ}.46' - 10,217229 \\ \quad :: \text{s, dist. } 12^{\circ}.50' - 9,346579 \\ \quad : \text{ct. bearing } 69^{\circ}.53' = 9,563808 \end{array}$$

$$\begin{array}{l} 5. \text{ R : t. X lon. } 13^{\circ}.43' - 9,387536 \\ \quad :: \text{cs, lat. } 58^{\circ}.46' - 9,714750 \\ \quad : \text{t. arc dist. } 7^{\circ}.13' = 9,102286 \end{array}$$

$$\begin{array}{l} 6. \text{ R : t. greatest lat. } 58^{\circ}.46' - 10,217229 \\ \quad :: \text{s, dist. } 7^{\circ}.13' - 9,099065 \\ \quad : \text{ct. bearing } 78^{\circ}.18' = 9,316294 \end{array}$$

The whole distance in the arc $2582^{\frac{1}{2}}$
The distance between the Lizard } $1582^{\frac{1}{2}}$
and the place of the greatest lat. }

The distance from thence to C. Jones 1000

The Lizard is in $43^{\circ}.43'$ E. lon.
from the place of grt. lat. Subt. 10

Lon. of the place, which } $33^{\circ}.43'$
is 10° W. of the Lizard - }

Subtract 10

Diff. of lon. from greatest lat. $23^{\circ}.43'$

Subtract 10

X lon. from the place of the } $13^{\circ}.43'$
greatest lat. - }

This is 30° from the Lizard.

Lon. from the place of greatest latitude.

To Cape Jones $29^{\circ}.59'$

Subtract $9^{\circ}.59'$

Greatest lat. 20

Subtract 10

Rem. 10

To find the bearing at 10° W. from the Lizard.

As s, X lon. : s, dist. from the place of
greatest lat. :: cs, greatest lat. : s, bearing.

$$\begin{array}{l} \text{Or, R : t. greatest lat. } 58^{\circ}.46' - 10,217229 \\ \quad :: \text{s, arc of diff. } 7^{\circ}.17' - 9,103531 \\ \quad : \text{ct. bearing } 78^{\circ}.11' = 9,320762 \end{array}$$

$$\begin{array}{l} 19^{\circ}.05' \\ 12^{\circ}.50' \quad 2d \text{ part } \left\{ \begin{array}{l} 12^{\circ}.50' \\ - 7^{\circ}.13' \\ \hline 5^{\circ}.37' = 337 \end{array} \right. \\ 6^{\circ}.15' = 375, \end{array}$$

7. R : t.

* To the place of the greatest latitude.

7. R : t. X lon. $20^{\circ}.00'$ — 9,561066
:: cs, greatest lat. $58^{\circ}.46'$ — 9,714750
: t. arc dist. $10^{\circ}.41'$ — 9,275816
8. R : t. greatest lat. $58^{\circ}.46'$ — 10,217229
:: s, arc dist. $10^{\circ}.41'$ — 9,268065
: ct, bearing $73^{\circ}.00'$ — 9,485294
9. R : t. X lon. $10^{\circ}.00'$ — 9,246319
:: cs, greatest lat. $58^{\circ}.46'$ — 9,714750
: t. arc dist. $5^{\circ}.13'$ — 8,961069
10. R : t. greatest lat. $58^{\circ}.46'$ — 10,217229
:: s, arc dist. $5^{\circ}.13'$ — 8,959361
: ct, bearing $81^{\circ}.27'$ — 9,176590

Bearings.	lat.	Arc of dist.	lon. W. of Lizard
1. N. $53^{\circ}.47'$ W.	50.00° N	437m.	10.00° W
2. N. 61.40° W.	53.54	375	20.00
3. N. 69.53° W.	56.25	337	30.00
4. N. 78.18° W.	57.35	433	43.43
5. 90.00° W. in	58.46	1582	53.43
6. S. 81.28° W.	58.23	314	63.43
7. S. 73.00° W.	57.10	327	73.42
8. S. 64.42° W.	56.13	359	
Arrived at the Port.	55.00	2582	

To find the latitudes through which the arch passes, in any given longitude W. from the Lizard, by having given the greatest latitude and the longitude from it.

Gen. Canon. R : t. greatest lat. :: cs, X lon. between the given place and the place of the greatest lat. : t. of the lat. sought.

R : t. $58^{\circ}.46'$ — 10,217229
:: cs, 10.00 — 9,993351
: t. lat. 58.23 — 10,210580
:: cs, 20.00 — 9,972986
: t. lat. 57.10 — 10,190215
:: cs, 25.00 — 9,957276
: t. lat. 56.13 — 10,174505

Remark, That it is impossible to sail any considerable distance in the arch of a great circle; therefore, to lay down a method that may be easily applied (which has not been done by any author of navigation), is what I here exhibit, and is as follows.

GENERAL METHOD.

1. Find by Prob. IV, the bearings and dist. of the two places from each other; by Prob. V, find the place of greatest lat. and the dist. of each place in the arc of a great circle, from the place of the greatest lat. find also the longitude of the place of the greatest latitude.
2. Divide the arc of distance between each place and the place of the greatest latitude, by the number of quarter points of the compass contained between the E. or W. point, and the nearest point and quarter of the bearings; the quotients will shew the number of miles to sail on each course, from one of the places to the other.
3. With the courses, which increase one quarter in succession, and the distances, find the diff. of lat. and departure.
4. Find the mid. lat. and the lon. made on each course, as are fully shewn in the following Table.

Suppose a ship is to sail from the Lizard to Cape Jones in N. America; and it is proposed for her to sail as near the arc of a great circle as may be, and to alter her course at the end of each distance, one quarter of a point. By Prob. IV, the bearing from the Lizard is N. $53^{\circ}.46'$ W. which gives 13 courses. And the dist. from the Lizard to the place of the greatest lat. 1582 miles, divided by 13, gives 122, the miles to be sailed on each course: But in this I have taken 130, by which the place of passing the meridian of greatest lat. happens to be $43'$ S. of the place proposed to pass the meridian of greatest latitude.

By the following table it appears that by failing these courses and distances, there will only be 8 miles more than that in the arc of a great circle; and 108 less than by mercator's method of sailing. By this it is evident what advantages may be gained with the practice of this method in some cases, in large distances, and in high latitudes; that is in latitudes exceeding 45° , and whose diff. of longitudes are not less than 60 or 70 degrees.

Courses.

Courses.	Dist.	X Lat.	Dept.	Lat. in.	Lon. made.	Tot. made.
1. NWbW.	130	72,2N	108,1W	51,12N	2.51W	2.51W
2. NWbW $\frac{1}{4}$ W.	130	66,8	111,5	52,19	2.59	5.30
3. NWbW $\frac{1}{2}$ W.	130	61,3	114,7	53,20	3.08	8.58
4. NWbW $\frac{3}{4}$ W.	130	55,6	117,5	54,15	3.17	12.15
5. WNW.	130	49,8	120,1	55,05	3.26	15.41
6. WNW $\frac{1}{4}$ W.	130	43,8	122,4	55,49	3.35	19.16
7. WNW $\frac{1}{2}$ W.	130	37,7	124,4	56,27	3.43	22.59
8. WNW $\frac{3}{4}$ W.	130	31,6	126,1	56,59	3.50	26.49
9. WbN.	130	25,4	127,5	57,24	3.56	30.45
10. WbN $\frac{1}{4}$ W.	130	19,1	128,6	57,43	4.00	34.45
11. WbN $\frac{1}{2}$ W.	130	12,7	129,4	57,56	4.04	38.49
12. WbN $\frac{3}{4}$ W.	130	6,4	129,8	58,02	4.05	42.54
13. Ditto (1585)	26	1,3	26,0	58,03	0.49	43.43
14. W.	100	—	100,0	—	3.09	46.52
15. W $\frac{1}{4}$ S.	200	10,0	200,0	57,53	6.18	53.10
16. W $\frac{1}{2}$ S.	100	9,8	99,5	57,43	3.08	56.18
17. W $\frac{3}{4}$ S.	100	14,7	98,9	57,28	3.02	59.20
18. WbS.	100	19,5	98,1	57,09	3.00	62.20
19. WSW $\frac{1}{4}$ W.	100	24,3	97,0	56,45	2.58	65.18
20. WSW $\frac{1}{2}$ W.	100	29,0	95,7	56,16	2.53	68.11
21. WSW $\frac{3}{4}$ W.	100	33,7	94,2	55,42	2.48	70.59
22. WSW. (1000)	100	38,3	92,4	55,04	2.42	73.41
Sailed 2585 miles.		—	—	X lon.	29.58 from the place of greatest lat.	
To Port 5						
Total 2590						

To work the foregoing Question with 13 Courses to the greatest Lat. and 122 Miles distance on each Course.

No.	Courses, Dist.	X lat. N.	Dept. W.	M. lat.	Lon. made.	Lizard = 49° 57' N.
1	NW. 4 $\frac{3}{4}$ pts. 122	72,7	98,0	50 $\frac{1}{2}$	2.34W	Lat. made 8.46 N.
2	5 122	67,8	101,4	51 $\frac{1}{2}$	2.43	Our gft. lat. 58.43 N.
3	5 $\frac{1}{4}$ miles each course.	62,7	104,6	52 $\frac{1}{2}$	2.52	which is only 3' S. of the
4	5 $\frac{1}{2}$	57,5	107,6	53 $\frac{1}{2}$	3.01	greatest lat. in the arch.
5	5 $\frac{3}{4}$	52,2	110,3	54 $\frac{1}{2}$	3.10	
6	6	46,7	112,7	55 $\frac{1}{2}$	3.19	
7	6 $\frac{1}{4}$	41,4	114,8	56 $\frac{1}{2}$	3.28	
8	6 $\frac{1}{2}$	35,4	116,8	57	3.35	
9	6 $\frac{3}{4}$	29,6	118,3	57 $\frac{1}{2}$	3.40	
10	7	23,8	119,6	58	3.45	
11	7 $\frac{1}{4}$	17,9	120,7	58	3.48	
12	7 $\frac{1}{2}$	11,9	121,4	58 $\frac{1}{2}$	3.52	
13	7 $\frac{3}{4}$	6,0	121,9	58 $\frac{1}{2}$	3.53	
The sum made =		525,6	1468,1	—	43.40W	
Our place of greatest lat. 58.43 N.						
Shall make by 8 courses 3.33S. and 29.20W						
Lat. then 55.10N. and lon. 73.00W						
Lat. for 55.00N. lon. for 73.42W						
To make .10S. and .42W						
which gives the course W.S.W. dist. 26 miles.						

K k

The

The dist. failed on 13 courses 1586

Do. on 8 — 976

Do. on 1 — 26

Total 2588

In the arc of the great circle 2582 } Which is only 6 miles more than that in the arc of the circle.

By this practical method the whole calculation may be made in one tenth of the time used in the old method.

Suppose two places in the lat. of 50° N. and their diff. of lon. $47^{\circ}.36'$: What is their dist. and bearing in the arch? And what the greatest lat. of the arc? Let the places be the Lizard and Penguin Island.

1. By Prob. 2, R : ct. lat. $50^{\circ}.00' = 9,923813$
 $::$ cs, $\frac{1}{2}$ X lon. $23.48 = 9,961402$
 : ct. greatest lat. $52.29 = 9,885215$

3. R : t. $\frac{1}{2}$ diff. lon. $23^{\circ}.48' = 9,644490$
 $::$ s, of the lat. $50.00 = 9,884254$
 : ct. of the bearing $71.20 = 9,528744$

To find the dist. in a parallel circle.

R : X lon. $::$ cs. lat. : dist. $1836 = 30^{\circ}.36'$

2. R : cs, lat. $50^{\circ}.00' = 9,808067$
 $::$ s, $\frac{1}{2}$ diff. lon. $23.48 = 9,605892$
 : s, $\frac{1}{2}$ dist. $15.02 = 9,413959$

$\times 2$

Dist. $30.04 = 1804$ mi.

The places bear from each other N. $71^{\circ}.20'$ W. and N. $71^{\circ}.20'$ E.

The greatest lat. of the arc $52^{\circ}.29'$ N.

Dist. 30.04

The Lizard and Penguin Island being the places; their dist. is 1804 m. and the first course for a ship to sail from the Lizard is W.N.W. $\frac{1}{2}$ W. dist. about 200 miles: Suppose this to be so; What course must she sail 200 miles more, so as to be near the arc of a great circle between the ship, and the place bound for? We have the course and distance given, to find the diff. of lat. diff. of lon. and the lat. the ship will be in at the end of the first course.*

By the Traverse Table, the diff. of lat. is $58'$ N. and her dep. 191.4 W. hence her lat. at the end of 1st course is $50^{\circ}.58'$ N. and the mid. lat. is $50^{\circ}.29'$, by which I find the X lon. to be $304' = 5.04$ W.

To find the SECOND COURSE.

Half diff. of lon. $23^{\circ}.48'$ | R : t. $18^{\circ}.46' = 9,53119$
 made 5.04 | $::$ s, lat. $50.58 = 9,09029$
 Lon. to make 18.46 | : ct. cou. $87.36 = 8,62148$
 to the place of greatest lat. | Course to sail 200' is WbN.

By Traverse Table. Over 7 pts. dist. 200 m. gives X lat. 39° N. dep. 196 W.

Lat. in $51^{\circ}.37'$ N. mid. lat. $51^{\circ}.18'$ dep. 196.

Gives lon. 312 W. = $5^{\circ}.12'$ W.

Subtract from 18.46

X lon. to greatest lat. 13.34

To sail N. $7\frac{1}{4}$ W.	200'
$7\frac{1}{4}$	200
$7\frac{3}{4}$	100

Note, the $\angle$ of the course is $6\frac{1}{4}$ points; hence there are 7 courses to fail, to the place of the greatest lat. its dist. 902 miles. Now $7)902$ (129 miles to be failed on each course, one with another, to the meridian of the place of the greatest latitude.

In Atkinson's Epitome, p. 190, Case 2d of Great Circle Sailing, the foregoing Problem is proposed, and after filling 6 pages, and calculating courses (or positions) to be failed, which cannot be done; there results the whole distance 1822 miles, which is 14 miles more than by the method here laid down; the other, as described by former authors who have wrote on the subject, being impractical; and therefore of no use: I think, I may justly say, the method here shewn is the first practical method.

Suppose a ship sailed from 50° N. lat. the following courses and distances: How many miles more must she fail to her port, whose difference of longitude is $47^{\circ}.36'$ W. in the parallel of 50° N.

* See General Rule, p. 127.

Courses.	Dist.	X lat.	Dep.	Lat. in.	Lon. made.	Tot. made.	X lon. 47°.36'
1. WNW $\frac{1}{4}$ W.	60	20,2	56,5	50.20N	1.28W	1.28W	Half do. 23.48
2. WNW $\frac{1}{4}$ W.	100	29,0	95,7	50.49	2.31	3.59	Made 19.51
3. WNW $\frac{1}{4}$ W.	150	36,5	145,5	51.26	3.51	7.50	To make 3.57
4. WbN.	150	29,3	147,1	51.55	3.56	11.46	
5. WbN $\frac{1}{4}$ W.	150	22,0	148,4	52.17	4.01	15.47	
6. WbN $\frac{1}{4}$ W.	150	14,7	149,3	52.32	4.04	19.51	
7. W.	144,3	—	144,3	—	3.57	23.48	

The miles - 904 failed to the meridian of greatest latitude.
 To fail - 904 on the other courses in the S.W. quarter.
 1st course W. the 2d WbS $\frac{1}{4}$ W. the 3d WbS $\frac{1}{4}$ W. the 4th WbS. and so on, the like distances as before, and you will obtain the port desired, Penguin Island, and only make 4 miles more in distance than in the arc of a great circle.

* Thus over 52° is 146,0
 over 53 is 142,6

Mean $52\frac{1}{2} = 144,3$, which 144,3 set down in dep. col. and the same in dist. col. and you will obtain the place of the greatest latitude. See table above.

Prob. 110, p. 588, Robertson's Navigation, his 2d Question of Great Circle Sailing.

A ship bound from the Lizard to the island of Bermudas, proposes to sail on a great circle (i. e. as near the arc of a great circle as possible), and to alter her course at each 5 degrees of longitude: Required the latitudes through which the ship is to pass, and also the course and distance between each.

Bermudas 32°.25'N	co-lat. 57°.35'
Lizard 49.57 N	co-lat. 40.03
Diff. of lon. 62.24	Sum 97.38
Half diff. of lon. 31.12	Diff. 17.32
Half Sum 48.49	s, 0,123432
Half diff. 8.46	s, 9,183016
ct. of half X lon. 31.12	= 0,217799
t. half X of the bearings 18.29 $\frac{1}{2}$	= 9,524247
t. half Sum of the bearings 68.01 $\frac{1}{2}$	10,394159

Bearing of Bermudas 86.31 from the Lizard
 Do. of the Lizard 49.32 from Bermudas.

By Robertson's Navigation, the positions are 87°.15' and 49°.35', both of which are wrong, and so is his distance.

As s, of the arc bearing 86°.31' — 0,000803
 : cs, lesser lat. 32.25 — 9,926431
 :: s, X lon. 62.24 — 9,947533
 s, dist in the arch 48.32 $\frac{1}{2}$ = 9,874767
 60

Distance miles 2912 $\frac{1}{2}$
 Robertson's distance 2874,
 By Prob. 23, Sherwin's, 2912,50

arch of a great circle is the nearest distance between any two places upon the spherical surface of the earth.

2. The course and distance by mercator's, is S. 69°.02' W. dist. 3009,8 miles, and may be called 3010, which is 97 miles more than in the arch; for since the constant course makes the path of a ship, to the Southward of that in the arc of a great circle, it must therefore contain a greater number of miles in the distance, as the meridians in that path are at a greater distance from one another.

3. By

3. By dividing the arc of distance into several parts, and then making a direct course and distance for each part of such arc by which the distance to sail on a constant course from one part of the arc of the great circle to another, will a little exceed that of the arc; and the sum of these several distances to be sailed on the courses from place to place, will exceed the arc of the circle; but the sum of those will be much less than that of the single course.

These calculations are very troublesome; and unless the utmost accuracy be used in obtaining the courses and distances to be sailed, you may commit one continued error. Where the sum of the polygonal distances * to be described about the arc of the great circle, may happen to be less than the circular arc; which is Mr. Robertson's case.

I have computed the courses to be sailed, and distances, from one latitude of the arc to another, which are as follows: but it will be necessary for a clear illustration, to draw a chart of a spherical kind, which let be of a part of the earth between the latitude 48 and 56° N. and W. longitude from the meridian of the Lizard.

Thus 48°	Means:	Miles in 1° of lon.	As 3,3 : 4° lat. :: 38,57 : 46°,75 for the radius of the chart, between the center and the parallel of 50°.	But 4° give 3,3
Mid. lat. 52	50	38,57		2 — 1,65
Ext. lat. 56	54	35,27		1 — 0,825
Diff.	- 4 and 3,3			

Let $\frac{1}{10}$ of an inch contain 60' or 1° of the arch of a great circle, then each tenth of an inch will contain 10 miles in the chart. See fig. A, in plate 3.

The VARIATION of the NEEDLE accurately observed.

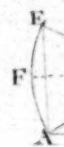
- In the bay off Funchal, variation 19° W. Dip of the needle 77°.18'.
- In lat. 0°, lon. 30° W. Dip off the Northend of needle 27°.
- In June 1774, I observed the variation by Whitehall, London, 22°.24' W. and 22°.25'; and the dip off the Northend of dipping needle 72°.
- In September 1774, the mean of 20 observations gave the dip 71°.40'.
- In July, 1775, the variation 23°.10' W.
- In June, 1776, do. 23°.20' W. 23°.20, 23°.20 and 23°.25'.
- In November 1776, do. 23°.35' W. by the meridian line.

Times of High Water on the Full and Change Days of the Moon.

	h. m.		h. m.
At Ushant	4 30	Cape of Good Hope	3 00
Millford, Wales	5 15	Isle of St. Catharine's, Brazil,	4 30
In the bay of Biscay	3 00	P. St. Julian, Patagonia	4 45
River Tagus, Portugal	2 15	Ashley river, Carolina,	3 00
River Senegal, Africa	10 30	Cape Henry, Virginia	11 15
Isle of Teneriff	3 00	New York	3 00
St. Helena	2 30	Long I. New England	3 00

* Or more properly, mercatoral distances, to be sailed.

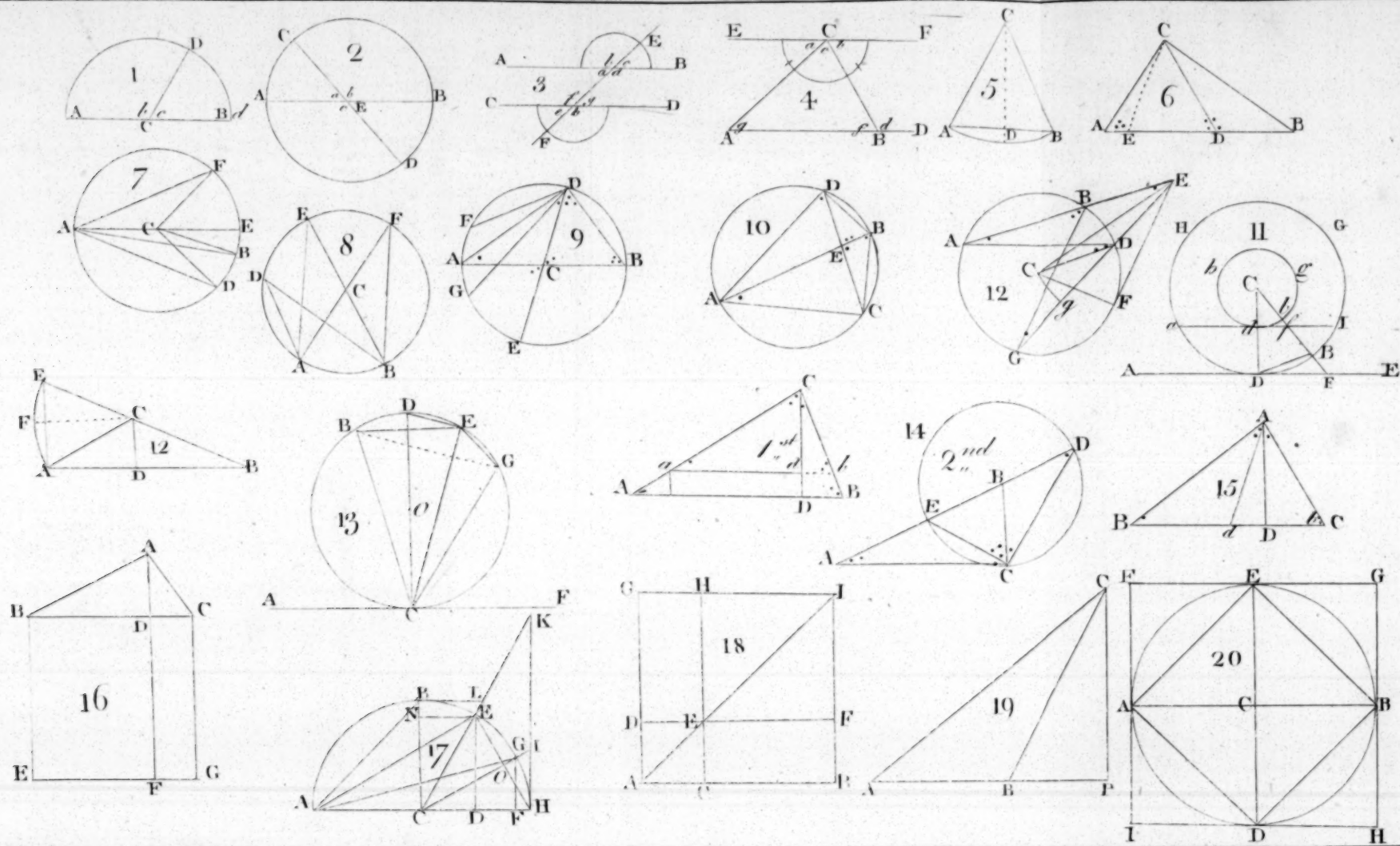




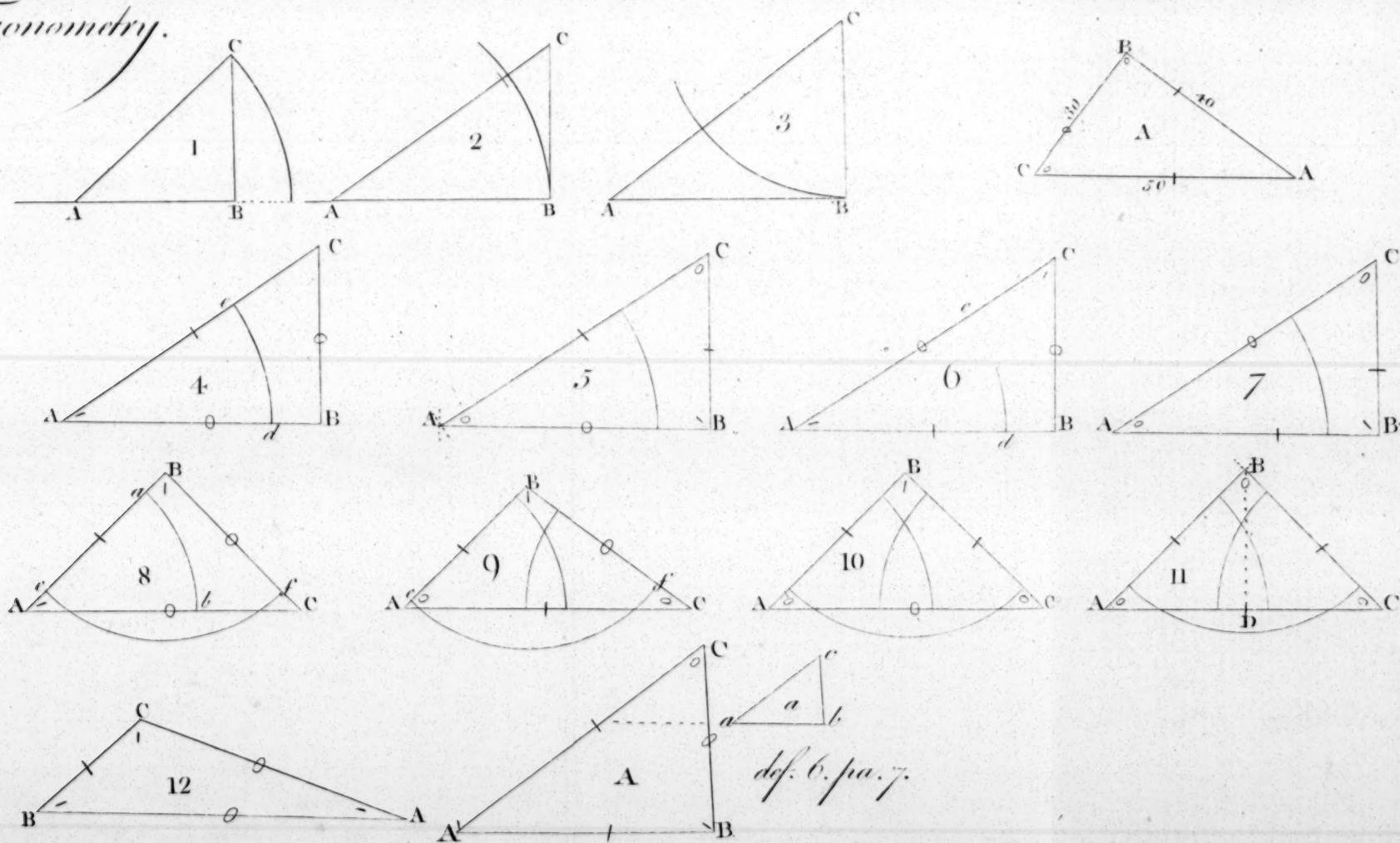
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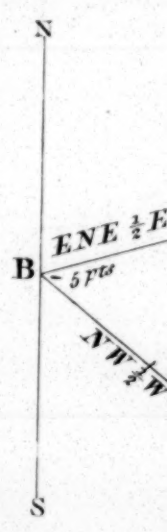
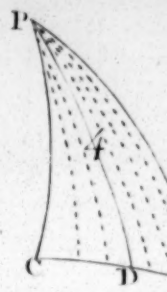
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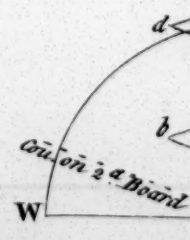
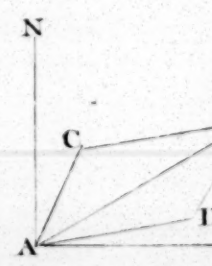


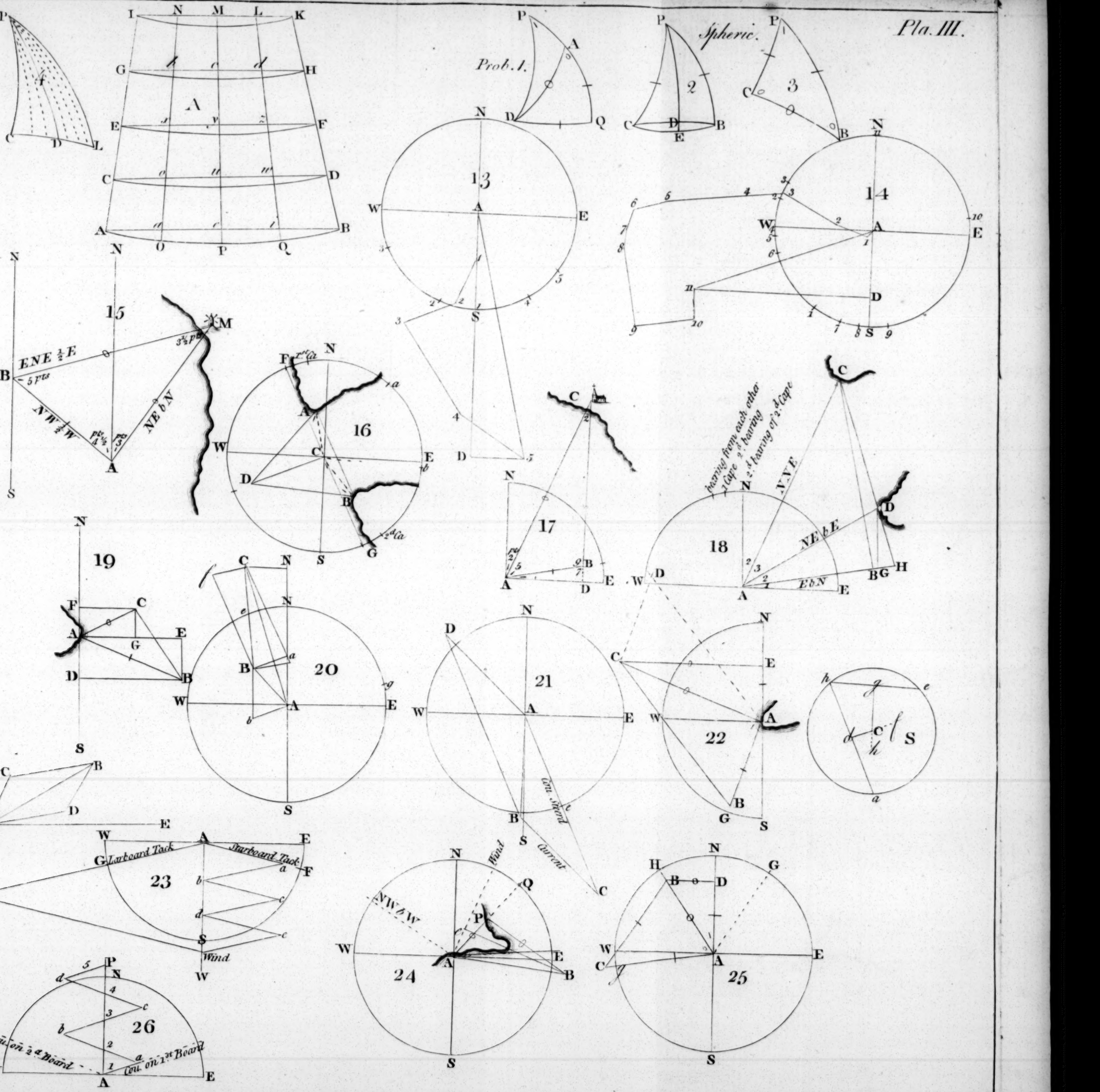
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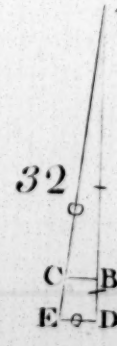




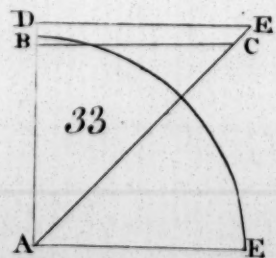
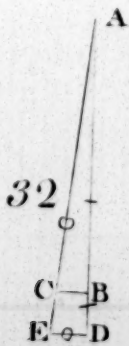
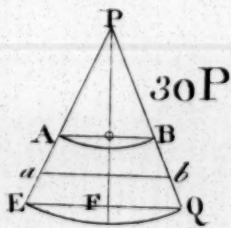
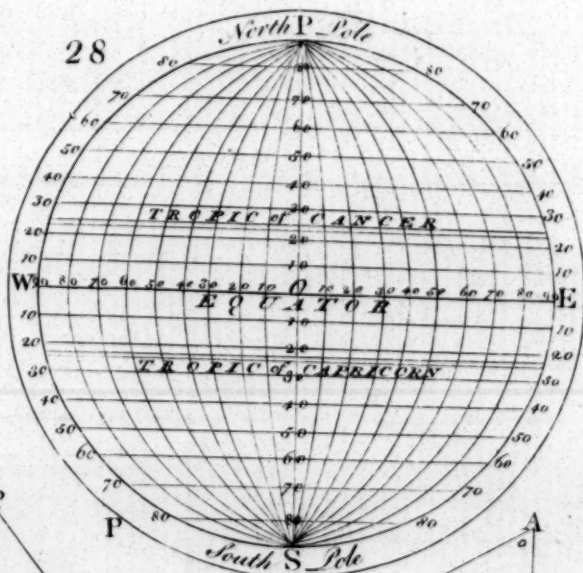
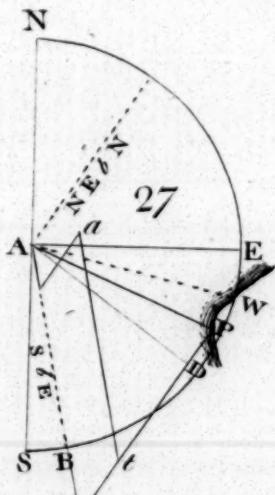
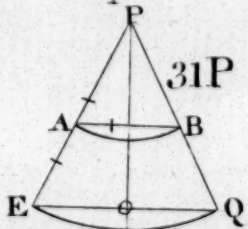
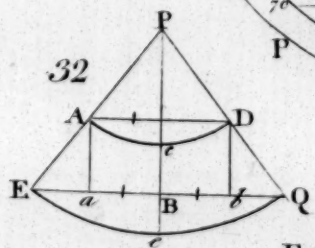
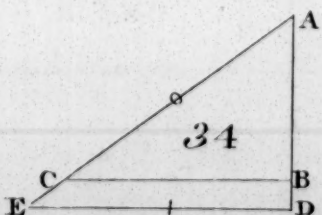
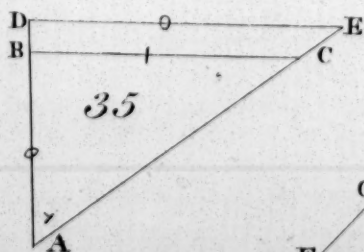
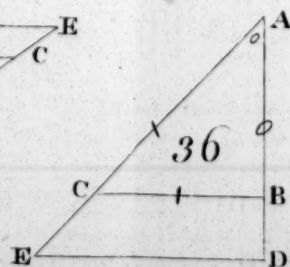
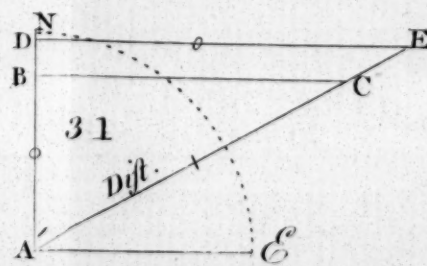
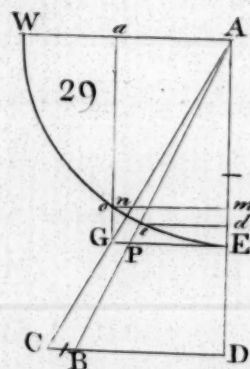
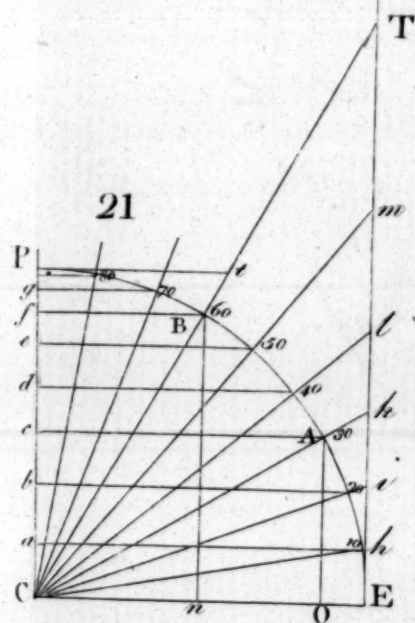
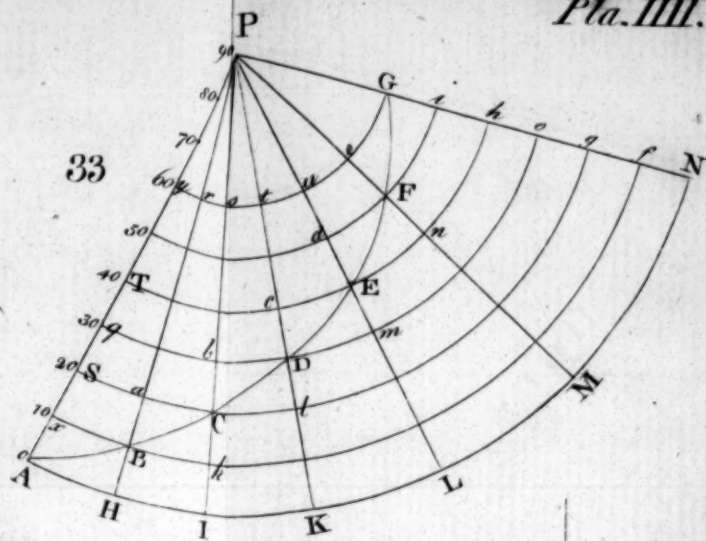
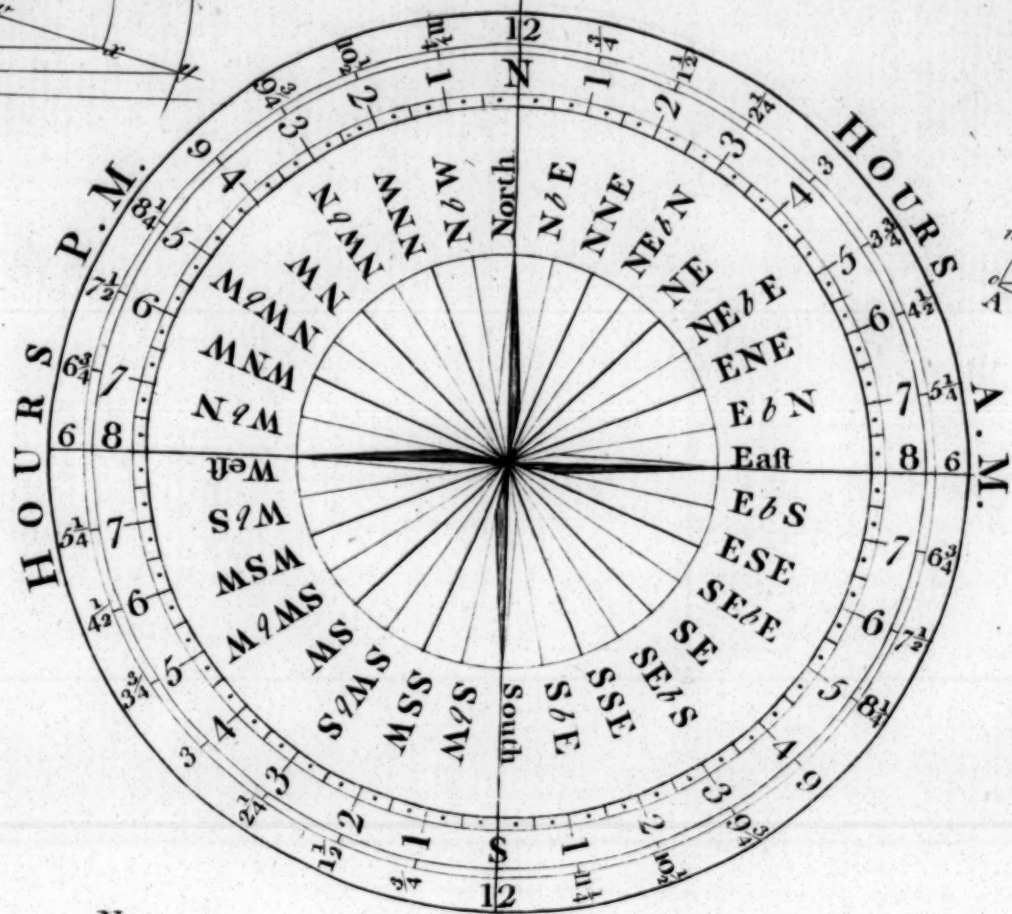
F
A
D







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A MERCATOR'S CHART

